The Dock and Harbour Authority

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Editorial Comments

A Rising Australian Port.

The investigation of the origin of things is always interesting and, for the student, possesses a singular fascination. This is true whether the subject of research be astronomical, geological, biological or historical. Equally does it hold good in the sphere of trade and commerce and, not least, in the development of ports. It is with pleasure, then, that we include in this issue a detailed analytical study by the Minister of Works and Local Government in New South Wales of the growth and expansion of a port in the Antipodes, which, from a primitive and rudimentary environment, has already emerged, within a period of less than forty years, to a position of importance, and by reason of its local mineral resources, seems destined to play an outstanding part in the future history of the Commonwealth.

Up to the commencement of the present century, Port Kembla was merely an open roadstead on the southern portion of the New South Wales coastline, and active operations for the construction of an adequately sheltered harbour were only undertaken in 1901. This step was brought about by a recognition of the striking potentialities of the Illawarra Coalfields, which lie in close proximity to the town, and from which, since their exploitation to a fuller extent in recent years, there has been a steady and increasing output. As pointed out in Mr. Spooner's paper, the average annual production of coal since 1907 has approximated to two million tons, and in view of the fact that the officially estimated reserves of the southern coalfields in New South Wales, of which the Illawarra field forms the most important part, are between three and four thousand million tons, there are undoubtedly immense possibilities of future expansion.

One important respect in which the influence of these carboniferous deposits has made itself felt is in the generation of electricity, a feature, the consideration of which, since it has little direct bearing upon dock and harbour interests, we have regretfully felt constrained to omit from the comprehensive review of local activities in Mr. Spooner's paper.

But, in order to present the picture in its proper perspective, it is certainly desirable to make some mention of the great industrial movement which has resulted from the creation of power through the abundant supply of cheap coal, combined with convenient cooling water facilities. Consequent upon the foresight and initiative of an enterprising pioneer, Mr. Corin, who visualised the possibility of making Port Kembla the electrical generating centre for the service of the whole of the adjacent countryside, power stations have sprung up in various parts, so that the horse power of electric motors in State Factories at the present day has reached the half-million mark.

Further developments may be expected to follow the project now in hand for linking up the Port Kembla and Burrinjuick systems, whereby, during certain seasons of the year, excess power, available from the latter source, will be utilised in the Port Kembla area with a consequent saving in fuel costs.

But while coal exportation is a matter of prime importance in the locality, coal is not the only commodity to be taken into account in the development of the port accommodation. There is already a considerable incoming traffic in ores and other raw materials for the smelting and steel works in the neighbourhood, and, as will be seen, the new jetty is designed with a view to its use for the reception of general cargo. Moreover, demands for facilities for the oil trade will have to be satisfied, and there is every prospect of Port Kembla becoming a centre for the distribution of inflammable liquids in the surrounding district.

The inter-relationship between local industrial production and commercial development is obviously a factor having a profound bearing on the fortunes of a port, and as these are in favourable conjunction at Port Kembla, there is good reason to expect a rising standard of prosperity at this young and enterprising town which already ranks as one of the leading ports of New South Wales.

Seaplane Bases.

The search along the Southern coast of England for a safe and commodious base for seaplanes engaged on Empire Service has not, so far, been attended by a completely satisfactory result. At first, Langstone Harbour appeared to offer substantial advantages, but differences arose with the Corporation of Portsmouth in connection with the negotiations for the site. Then the Air Ministry turned their attention to Southampton Water, and an arrangement was come to with the Southampton Harbour Board by which a substantial extent of water surface was to be set apart for the use of the Ministry. Unfortunately, it has since come to be realised that the proximity of this area to the busy traffic lines of shipping in and out of the port constitutes a serious danger, and that the primary requirement of amplitude of space for aerial manœuvring, especially at times of poor visibility, accentuated during foggy or stormy weather, is scarcely met to an adequate degree.

Attention is now being directed to Pagham Harbour, a natural inlet west of Bognor Regis and north of Selsey, which, while not so capacious as the other two sites, is capable of enlargement by dredging, and, it is claimed, offers the advantage of shelter and protection without obstruction to freedom of aerial movement from high ground, from shipping or from adjacent industrial development. The question of cost requires consideration, but the opinion is held that this aspect of the matter is not unfavourable.

A Nicaraguan Ship Canal.

The subject of Ship Canals has been much to the fore of late, whether as regards their enlargement, as in the case of the Corinth and Kiel Canals, or as regards the inception of fresh enterprises, such as the proposed Two-seas Canal across the South of France, to which we referred in our issue of February. Another project, now the subject of discussion, is the formation of a canal across Central America through Nicaraguan Territory. The idea is by no means new; it is really a revival of one of the original schemes under consideration towards the end of last century, when de Lesseps embarked on his second and less fortunate ship-canal venture. Indeed, to find the origin of the matter, it would be necessary to go back to the year 1550, when the Portuguese navigator, Antonio Galvao, published a book in which he sought to demonstrate that an isthmian canal could be cut along any of four routes, one of them lying in Nicaragua. Nothing came of these proposals at the time.

Within more recent years, a United States Commission, after an investigation extending over a lengthy period reported in 1876, that the Nicaraguan route possessed greater advantages and

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offered fewer difficulties than any of the others, but in 1880, de Lesseps, with his French colleagues, got started on his own Panama project, the work on which was finally brought to a standstill from lack of funds in 1889. A new Company was formed in 1894, and operations were then resumed for a time.

Meanwhile, in 1886, a Nicaraguan Canal Association was inaugurated in New York with American capital, and a concession for the route was obtained from the Nicaraguan Government in the following year. In 1889, the Association was incorporated by the U.S. Congress, and work was actually begun in June, 1889, continuing till 1893, when the concern became involved in bankruptcy.

Then, in 1899, the United States Isthmian Canal Commission, reviewing the situation afresh, reported that there was no route which did not present greater difficulties than those of Panama and Nicaragua, and recommended the latter.

Finally, in 1902, on account of financial difficulties, came the offer to sell the Panama undertaking, as far as it had then progressed, to the American Government. This offer was ultimately accepted, and the Nicaraguan scheme was dropped.

On a comparison of the two routes, the advantage of shorter distance lies with Panama. The Nicaraguan crossing in a straight line is 156 miles long, but more than one-third of this is covered by Lake Nicaragua, which has an area of some 3,000 square miles, with a maximum depth of over 200-ft. The surface level of the lake is about 105-ft. above sea level, a rather greater elevation than that of the artificial Gatun lake in Panama. Furthermore, while Lake Nicaragua is connected with the Atlantic by a navigable river, the San Juan, it is separated from the Pacific by the Continental Divide, with a summit about 160-ft. above sea level.

The design for the present project, as surveyed and laid down by the U.S. Army Engineers between 1929 and 1931, follows a route which is 173 miles long, of which 70 miles would be channel through Lake Nicaragua. There would be two flights of locks, one at each end of the canal, with chambers 1,200-ft. long and 125-ft. wide, compared with the Panama locks, which are 1,000-ft. long and 110-ft. wide. The cost of construction was estimated at 145 millions sterling, and the annual maintenance at two millions.

The chief argument advanced for the construction of the canal is not so much commercial as political, due to the international tension prevailing at the present time. A single canal, of arterial importance and fairly vulnerable as regards aerial attack, is bound to be a source of much anxiety to those to whom it is of valuable service. There is not so much fear that the structure of the canal could receive extensive permanent injury, as that it might be put out of commission at a critical juncture by some relatively trifling cause, such as the sinking, by design or otherwise, of a freighter in the fairway of the locks, or in the narrow passage through the Gaillard Cut, or again, by a breach in the dam at Gatun Lake. If the United States happened to be at war, necessitating naval operations simultaneously in the Atlantic and the Pacific, the delay in sending warships round Cape Horn might be of vital importance.

In its commercial aspect, the advantage of the alternative canal would be no less considerable. For United States coastwise traffic, there would be a reduction in the sea route between the East and West Coasts of some 700 miles. From the British point of view, the supplementary route would undoubtedly be helpful in maintaining communications with the Far East.

Turkish Port Development.

Some time ago, it was officially announced that the British Government had placed a credit of sixteen millions sterling at the disposal of the Turkish Government for the building of a mercantile marine and the commercial development of the country, part of the sum being assigned to the provision, or improvement, of suitable harbours. A Commission, which has since been sitting for the purpose of taking into account the various sites available for port development, has, at length, decided in favour of Tchatalaghzi on the southern shore of the Black Sea, about 15 miles from Zonguldak, as the first item in the programme of construction, and preliminary plans have prepared for a scheme involving an estimated expenditure of about two million pounds. Other ports likely to receive treatment later are said to be Trabson and Mersine.

The selection of Tchatalaghzi was influenced by the proximity of the coalfields at Zonguldak, and of the new iron and steel works at Karabuk, which are now in course of construction by a British firm and, presumably, nearing completion. Another consideration was the sheltered position of the port and its suitability for obtaining reasonably effective protection from storms. The design for the harbour includes two breakwaters, 3,000 yds. and 700 yds. long respectively. Facilities will be provided for the traffic of the locality, which is chiefly in coal and mineral ores.

Nothing, apparently, has been definitely decided in regard to the future of Istanbul, formerly known as Constantinople. This is a little surprising, as during a recent visit to the Eastern Mediterranean we were shown plans at Istanbul for the extention of the quayage accommodation there, including the provision of coal-handling equipment. Doubtless some part of the above-mentioned loan will be devoted to the expansion of the historical port and ancient capital of Turkey, which, under the capable and enterprising administration of the late Kemal Ataturk, was showing definite signs of modernisation and vigorous commercial activity. The city lies on the main railway line from Central and Western Europe to Asia Minor and the Persian Gulf and is, therefore, a traffic route of the first importance. Moreover, the Golden Horn provides excellent accommodation for shipping and a frontage which is capable of serviceable exploitation to a very considerable extent, if the necessary financial assistance is forthcoming. The Deniz Bank, with headquarters at Ankara but with its principal activities centred in Istanbul, is closely associated with the Port Administration, and has numerous shipping, harbour and shipyard interests.

The enlightened policy of the late President of the Turkish Republic is being actively pursued by the new President, Ismet Inonu, and there are anticipations of a welcome and important revival in Turkish overseas trade.

Port Labour Difficulties at Antwerp.

Matters, and especially labour matters, have not been going altogether smoothly at the Port of Antwerp. Ever since the introduction, a year or so ago, under legislative compulsion, of the seven-hour day for quayside labour, the prosperity of the port has suffered a decline, and in view of the loss of trade during 1938, and the unfavourable nature of the port returns compared with those of neighbouring competing ports, the business concerns interested in the welfare of shipping and commercial affairs feel that a review of the situation is imperative. The local labour organisations, however, are stubborn in their opposition to any modification of the existing working conditions, while, on the other hand, the employers contend that the seven-hour day is mainly responsible for the present unfortunate state of affairs.

Without a knowledge of all the circumstances, it would be inappropriate to make any remarks of a critical character, but there is a general principle involved, the importance of which is vital for all port undertakings. A ship is not a suitable warehouse for goods. The overhead expenses, due to the costly nature of the machinery and equipment, make it uneconomical to keep it moored against the quayside. It is unremunerative, except when engaged in its proper function of ploughing the seas. Therefore, any prolonged delay, and especially periods of idle time, during the discharge and reloading operations, are bound to affect adversely the shipping profits, and to tend to make the port a "dear" port, a reputation which does not improve the prospects of business, especially when in competition with neighbouring ports unhampered by such restrictions.

Parliamentary Questions.

The futility (to use no stronger term) of a great number—one might almost say the majority—of the questions on all sorts of topics put to Ministers in the House of Commons at a cost in time and service which could be devoted to better purpose in other directions, is well illustrated by a recent enquiry addressed to the Minister of Transport. Quoting from the official report, it was as follows: "Whether in view of the danger of destruction of essential food supplies and shipping, he will take steps to stop the further extension of London docks, proposed by the Port of London Authority to spend many millions of pounds, and to use the money for the proper development of dock facilities on other rivers more suitably located?"

Disregarding the involved and faulty grammatical construction of the sentence, it is obvious that the ineptitude of the suggestion was not apprehended by the questioner. The Minister did not enlighten him on the point, contenting himself with the reply that the extension of the London Dock system is a matter solely within the discretion of the Port Authority. If this leaves the impression, as it might possibly do, that the autocracy of the Port Authority governs the situation, the answer is unfortunate. No one who is conversant with the principles of commercial economics would be deceived for a moment. Although it is quite possible, and even desirable, to foster the development of trade by the provision of appropriate facilities, trade itself cannot be forced into channels to which it is not naturally attracted. And even assuming that there are "other rivers more suitably located" (which is entirely open to question) on what conceivable grounds could the resources of the Port of London Authority be diverted to the exploitation of other localities, to the neglect of the needs of the Metropolis? This is an aspect of the matter on which the questioner is discreetly silent, even if he is to be credited with giving it a thought. It is surprising how many people are under the mistaken impression that the Port of London Authority is a Government undertaking financed by the national exchequer.

Port Kembla

History of the Development of a New South Wales Port*

By the Hon. E. S. SPOONER, M.L.A.,
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Introduction

PORT KEMBLA HARBOUR (latitude 34° 29′ south, longitude 150° 56′ east) is situated on the South Coast of New South Wales, about 44 nautical miles from Sydney, and is controlled and administered by the Department of Works and Local Government.

Port Kembla was selected as the most suitable site on the South Coast for the construction of a deep sea port in view of its proximity to the Illawarra Coalfields and its possibilities in regard to rail connection with the South Coast and the Central and South-western portion of the State; the latter connection being now established by means of the Port Kembla-Moss Vale Railway.

Although discovered in 1797, coal in the Illawarra field was not worked until 1854, when the Mount Keira Colliery commenced operations, shipping from Wollongong. From 1854 to 1896 various other collieries opened up, shipping from Bellambi, Wollongong and Port Kembla.

In 1896, following representations from the colliery and commercial interests of the district, urging the construction of a deep-sea port on the South Coast, the Department prepared designs for a harbour at Port Kembla, under the direction of the then Engineer-in-Chief, Mr. Darley, I.S.O.

The proposal was submitted to the Public Works Committee, which, after hearing representative evidence and considering the claims advanced in favour of developing Bellambi, Wollongong and Lake Illawarra, decided on the construction of the port recommended by the Department at Port Kembla.

Port Kembla Harbour, looking North-West. Boat Harbour and No. 4 Jetty in foreground—No. 1 Jetty in background

The anticipation that these advantages would offer sufficient inducement for the establishment of large industries in the vicinity of the port is now being realised.

The more intensive development of the port, which has occurred since the establishment of the iron and steel industry in 1928, has necessitated expansion of the port facilities and electricity supply provided by the Government, and has also been responsible for increased Local Government activity to cope with the growing population.

It is proposed to treat the development of Port Kembla since its inception in 1898 from the following viewpoints:—

(1) Historical.
(2) Port Improvement.
(3) Industrial and Commercial Development.
(4) Local Government Works.
(5) Town Planning.
(6) Future Expansion.

1. HISTORICAL

In 1797 a man named Clark, one of the survivors of the ship "Sydney Cove," which was wrecked in Bass Strait, reached Sydney on foot after walking from Ninety Mile Beach, Victoria, and reported to Governor Hunter that he had discovered coal some distance south of Botany Bay.

Mr. George Bass, surgeon of the "Reliance," who was despatched by the Governor to verify this report, stated on his return that he had found a stratum of coal "6-ft. deep in the face of a steep cliff, which was traced for eight miles in length."

Bass, whose name is associated with that of Flinders in the celebrated voyages of the "Tom Thumb," had visited the district in 1796, but had apparently not discovered coal. On this occasion Bass and Flinders had landed at Wollongong, and the Tom Thumb Lagoon, between Wollongong and Port Kembla, perpetuates the name of their boat.

* Paper, slightly abridged, read before the Engineering Conference at Sydney of the Institution of Engineers, Australia, 30th March, 1938.

The Mines Department's Journal, "The Mining Industry of New South Wales, 1928," estimates the actual and probable reserves of the Southern Coalfields, of which the Illawarra field forms an important part, as approximately 3,468 millions of tons.

The average annual production of coal since 1907 has approximated two million tons, except for the depression years, when it slumped to under one million tons. The output has now recovered almost to pre-depression level, being 1.88 million for the year 1937.

It will be seen, therefore, that even allowing for substantial losses in extraction, the coal reserves of the Southern Coalfields should last many years at the present rate of production.

2. PORT IMPROVEMENT

The Port Kembla Harbour Act of 1898 authorised the construction of an eastern breakwater 2,800-ft. long, at an estimated cost of £200,000, this amount including provision for the resumption of lands and existing jetties valued at £41,700.

This approval limited the scope of Mr. Darley's scheme, which provided for two breakwaters—an eastern 2,800-ft. long, and a northern 3,530-ft. long, at an estimated cost of £440,000, including wharves and appurtenances.

Under this scheme the area enclosed would have been 271 acres at low water ordinary spring tides.

About 1912, Mr. Darley's scheme was revised in order to provide a greater area, and a design subsequently decided by the

Following the Committee's recommendation, the then Minister for Public Works, the Hon. James H. Young, introduced legislation to authorise the construction of Port Kembla Harbour, together with the necessary land resumptions, and an Act of Parliament was passed by the Reid Ministry in 1898. Preliminary work was started in 1900, the first stone being tipped in the eastern breakwater in 1901.

In deciding on the establishment of a deep-sea port on the South Coast, the Public Works Committee was influenced largely by the coal resources of the district.

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Harbour Improvement Committee, comprising various Chief Engineers of the Public Works Department and the late Messrs. Keele and Walsh, of the Sydney Harbour Trust, provided for an area of 344 acres at low water ordinary spring tides enclosed by a northern breakwater 3,263-ft. long, and an eastern breakwater 3,750-ft. long. The latest scheme, it will be observed, will enclose an area 73 acres larger than that proposed by Mr. Darley, or an increase in area of about 27%.

The various schemes proposed and that finally adopted and now nearing completion, are shown in the Supplement.

In the scheme finally adopted, certain objections were raised at the outset to the northerly aspect of the entrance.

Although this is the most favourable direction for shipping approaching the port, it was contended that the overlapping eastern wall might trap sand travelling from the north beach and cause silting in the harbour. Full inquiry into this possibility was made, and it was decided that such a danger was remote. Experience has vindicated this assumption, as although there has been some internal alteration in harbour contours with accretion in the vicinity of low-water mark, no dredging has been necessary up to the present to maintain the port to the full requirements of shipping offering. In fact, the only dredging carried out since construction commenced in 1900 has been in improving the original depth at certain berths or removing cargo spillage which had accumulated alongside jetties over a number of years.

Quarries

When harbour works were started in 1900, a quarry about a mile due south of the base of the eastern breakwater was selected after shafts had been sunk and rock tested. These shafts, unfortunately, gave a false indication of the general run of stone in the quarry, and in 1906 operations were transferred to Reids Hill, where a satisfactory quarry was found, after sinking shafts and boring with diamond drills. The quarry was used until 1928, when nearly three million tons of stone had been removed and the remaining stone available proved unsuitable for breakwater purposes. In 1928 a new quarry, which is still in operation, was opened at Gillans Hill, three miles west of Port Kembla and adjacent to Australian Iron & Steel, Ltd.'s Works.

The stone in the three quarries referred to is of volcanic origin, and is geologically known as Augite Andesite. It has a specific gravity of 2.79 and weighs 2.1 tons per cu. yd.

Stone used in breakwater construction has been limited to blocks over four tons in the eastern and over three tons in the northern, and the quarries used have yielded a satisfactory proportion of stone over this size up to 40 tons in weight.

Thirty-ton steam cranes are used for loading quarry waggons, which are constructed to permit either side or end tipping, and are hauled to the breakwater over standard gauge lines by side-tank bunker-type locomotives of about 40 tons weight, with six coupled driving wheels. These locomotives are capable of hauling a gross load of about 450 tons on the level.

Breakwaters

Eastern Breakwater.—This breakwater has a designed length of 3,750-ft., of which 3,536-ft. had been completed at June, 1937. The wall is of the mound type with a top width of 15-ft. at a height of 24-ft. above L.W.O.S.T. Side slopes, after consolidation by storms has taken place, have been found to be approximately 3 to 1 on the eastern or seaward side, and about $1\frac{1}{2}$ to 1 on the harbour side. The flatter outer slope is due to the action of heavy seas pulling stone down. This breakwater is required to take the full force of the heaviest seas which come from the south-east, and only stone over four tons weight has been used in its construction, while the outer or easterly face of the wall has been protected by the largest stone available, 10 to 40 tons in weight.

The present tip head of the wall is in 56-ft. of water, and the total height of breakwater at this point is 80-ft. with a base width of about 375-ft. This gives a cross section of approximately 1,700 sq. yds. and, allowing one-third for voids, the tonnage of stone required to construct one lineal foot of wall at the depth shown is approximately 800 tons.

When satisfied that further subsidence and consolidation due to heavy seas was unlikely to occur, it has been the practice to remove small stone under railway tracks and replace with concrete into which sleepers and rails were then bedded. Concrete used contained over 30% plums, and has served the purpose of holding together the crown of the breakwater and maintaining a permanent railway track to within a few hundred feet of the end of wall under construction.

Prior to the adoption of this concrete capping, severe damage occurred on the constructed length during coastal gales, and the efficacy of this treatment is evidenced by the fact that sections of breakwater constructed in this manner successfully withstand the heaviest seas with only occasional minor damage.

Side tip and end tip waggons hauled by locomotives have been used for placing the whole of the stone in this wall, no cranes or other plant being used except for loading in the quarry.

It might be pointed out that this work is the largest of its kind in Australia, and that the mound type of breakwater has been used with successful results on the harbours of New South Wales generally. This type, it is found, is most satisfactory in breaking the force of heavy seas.

Northern Breakwater.—The northern breakwater was completed to its designed length of 3,263-ft. in 1925. The general direction of this wall being end on to the heavier seas permitted a considerable length to be constructed of smaller stone not suitable for the Eastern Breakwater, but a minimum limit of three tons was fixed when 1,470-ft. had been constructed and the wall was completed with stone of this weight and over.

The Northern Breakwater is 21-ft. above L.W.O.S.T. at rail level or 3-ft. lower than the Eastern and the depth of water at its outer extremity is 50-ft., the total height being 71-ft.

Cross sections taken at this wall show an average side slope of 1.8 horizontal to 1 vertical on the other slope, and about 2 to 1 on the harbour slope.

In this instance the flatter slope is on the harbour side, the reason being that during construction this side of the wall did not obtain the protection it now has from the Eastern Wall during southerly seas, which flattened the slope on the harbour side.

The surface of this wall, where subjected to heavy seas over a length of about 1,250-ft. at its outer end, was concreted in the same manner as that described on the Eastern Breakwater.

The end of this wall, as shown in the Supplement, was finished with a bull-head of tipped stone with concrete cap to strengthen the seaward end against possible storm damage.

Eastern Breakwater—showing type of construction and Concrete Cap

Sea Wall, Boat Harbour and Crushing Plant

The limitation of the permissible minimum sizes of stone used in the Eastern and Northern Breakwaters to four tons and three tons respectively, has naturally resulted in a surplus of stone under this size being available from quarry operations.

This spoil has been disposed of in the sea wall along the western foreshore, in constructing a small boat harbour in the south-western corner of the port, and by sale to the State Metal Crusher, established first in Port Kembla, and later at Gillans Hill. This crusher is now owned by Quarries, Ltd.

The cost of quarrying and disposing of this spoil, which over the last five years has amounted to 60% of the total stone quarried, is charged against the other 40% of effective stone used in breakwater construction.

The sale of waste stone to the Metal Crusher is profitable to the Department, as it avoids the expense of haulage and disposal by the Department.

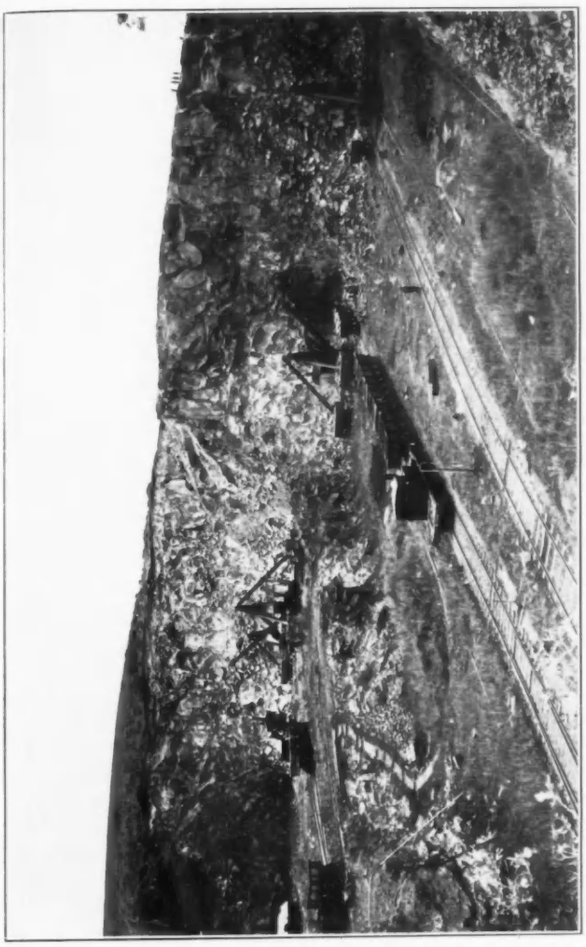
Quantities and Costs

From the beginning of construction in 1900 to 30th June, 1937, the total tonnage of stone placed in the Eastern and Northern Breakwaters amounted to 2,209,354, including stone placed in repair, but excluding spoil stone in sea wall, etc. The total cost of these breakwaters, excluding land resumptions, was £802,869, giving an average unit cost to date of 7s. 3d. per ton.

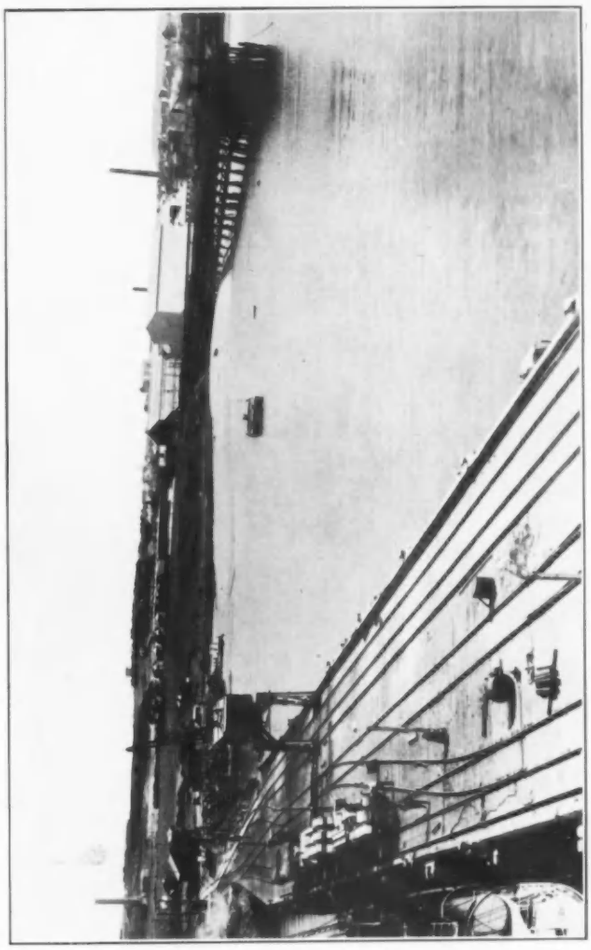
These costs, however, have been increased appreciably since the Great War, owing to rises in wages and material costs and a truer indication of present day costs for a work of this description is given by considering costs over the five years ended 30th June, 1937.

Over this period (July, 1932, to June, 1937) quarry operations have been confined to Gillan's Hill Quarry, three miles from Port Kembla, and construction of the Eastern Breakwater only has been in progress. A quantity of stone was placed on both Eastern and Northern Breakwaters in repairs to storm damage, and this quantity has been included in effective stone placed during the five years under review.

Port Kembla—continued



Gillans Hill Quarry and Cranes looking South



No. 4 Jettty looking South, showing 2-ton Electric Travelling Crane. No. 3 Jetty on right.

Truck depositing Coal in bin at base of No. 1 Jetty

Ship loading Coal at No. 1 Jetty

Port Kembla—continued

The following are particulars of stone quarried and costs of stone placed during the five years 1st July, 1932, to 30th June, 1937.

Quarry Operations

(a) Total tonnage quarried, 476,788 tons.
(b) Total tonnage placed in breakwater construction and repairs (over four tons), 191,432 tons.
(c) Balance placed in sea wall or sold to metal crusher, 285,356 tons.

Percentage of effective breakwater stone, 40.1%.

Costs

Quarry Costs		Construction	Costs		
Total tonnage Quarried	Unit cost per ton quarrying and loading	Tonnage placed in Breakwater construction and Repairs	Total cost of placing Breakwater stone, including cost of disposal of spoil in Sea Wall but excluding Land Resumptions	Unit Cost effective stone	Percentage age of Spoil
Tons	s. d.	Tons		s. d.	
476,788	4 2·7	191,432	£112,814	11 9·4	59·9%

Note.

The average basic wage in New South Wales over the period referred to above was approximately £3 9s. 0d. per week of 44 hours. The rate of 11/9.4 includes maintenance and depreciation of plant, survey investigation and design, supervision, insurance, holiday pay, quarry establishment and all items incidental to breakwater construction, but excludes costs involved in resumption and land matters as being variable with the location of the work and not directly chargeable to construction.

The cost of repairs to storm damage on the Eastern and Northern Breakwaters during the five years under review has amounted to £1,021 and £2,789, or about £205 and £558 per annum respectively.

Jetty Accommodation

In 1900 two coal companies operated in Port Kembla shipping coal over private jetties. Both jetties were resumed shortly after work commenced, and one, the No. 3 Mount Kembla Company's Jetty, was practically renewed, and is still in existence.

The No. 2 or Southern Coal Company's Jetty was used until 1916, when it became unsafe and shipping from it ceased. This jetty was entirely removed to high-water mark in 1925. Both jetties were of the high-level type, 31-ft. above low water, and coal was loaded direct in ships' holds by means of chutes placed between rail tracks under the hopper doors of coal trucks.

The No. 3 Mount Kembla Jetty has now passed its useful life for the class of shipping using the port, and Parliamentary authority has been given for its replacement by a modern jetty referred to later.

In 1908 the No. 4 low-level jetty, 500-ft. long, was constructed in the south-eastern corner of the port, and this jetty was extended by 300-ft. in 1929.

The No. 1 or Coal Loading Jetty, started in 1912, to replace the obsolete No. 2 Jetty referred to above, was completed and put into operation in 1915.

Australian Iron & Steel, Ltd.'s Jetty was built by the company in 1929 on land leased from the Department, and has special provision for handling iron ore in bulk, an electric transporter crane of approximately 20-ton capacity being provided.

The existing jetties in Port Kembla are Nos. 1, 3 and 4 (owned by the Department), and Australian Iron & Steel, Ltd.'s Jetty (private).

Brief details of the various jetties referred to are as follows:—

No. 1 Coal Loading Jetty.—This jetty has a total berthing length of 806-ft., with width between kerbs of 35-ft. The inner or shoreward section of the jetty is 537-ft. long, and 18-ft. wide between kerbs, the total length being 1,343-ft. from the end of subway. Deck level is 14-ft. above L.W.O.S.T.

The depth of water available varies from 35-ft. at the outer end to 29-ft. at L.W.O.S.T. 500-ft. inshore.

The structure carries the coal-loading plant designed by the Department under the direction of the late Mr. E. M. de Burgh, and installed under contract by Messrs. Kelly and Lewis in 1914. Coal in hopper trucks is brought by rail to the base of jetty where it is discharged into underground concrete hoppers, from which it is fed by a steel flight conveyor on to the main carrying belt travelling along the jetty. From the main belt coal is diverted to either or both of the travelling loaders and conveyed by boom belt and chute into hatches in any part of the vessel. The inner loader is capable of discharging coal into ships at a height of 39-ft. 6-in. above L.W.O.S.T., and the outer loader, which was raised in 1924, at 52-ft. 3-in. above low water.

The travelling loaders obviate the necessity of moving ships to load at various hatches and also reduce trimming.

The whole plant is electrically driven, and on test was found capable of a loading rate of 750 tons per hour. Owing to stoppages for trimming, this rate has never been attained in practice, and no average rate of loading can be quoted, as this depends on the type of vessel, the accessibility of holds and hatches, and whether coal is loaded as cargo or bunkers. The capacity of the plant in respect to cargo coal shipments may be gauged from the fact that the s.s. "Komura," loaded 3,390 tons in actual loading time of 6 hours, 32 minutes, or at the rate of 519 tons per hour. This rate is, it is believed, a record for coal loading in Australia.

No. 4 Low Level Jetty.—As originally constructed in 1908, to deal, principally, with the ores, matte, fluxes and other requirements of the Electrolytic Refining and Smelting Company and Metal Manufacturers, Limited, this jetty had a length of 500-ft. by 51-ft. width and a deck level 13-ft. 9-in. above L.W.O.S.T. In 1929 an extension of 300-ft. was added, making a total length of 800-ft. The actual berthing length of jetty is 500-ft., with a depth at low water varying from 36-ft. at the sea end to 24-ft. at a point 500-ft. inshore. The jetty is served by three standard gauge railway tracks which have direct connection to the State railway system at Port Kembla. Cargo handling equipment comprises one 5-ton and one 2-ton electric travelling crane fitted with grab buckets suitable for the handling of bulk cargo such as phosphatic rock and sulphur.

Vessels up to 10,000 tons gross and 450-ft. in length are berthed safely. The jetty is now used almost to full capacity by the major industries for both inward and outward shipments, and general cargo for Port Kembla and surrounding districts is also landed.

No. 1 Jetty looking shoreward—Coaling Belt

No. 3 Jetty.—The existing No. 3 high-level jetty, which is 45 years old, has been used up to the present solely for shipment of coal and coke in lighter draft colliers. The replacement of this jetty is now in hand, and further description of its facilities is not warranted. Particulars of proposed new jetty are given below.

Australian Iron & Steel Ltd.'s Jetty.—The jetty, now known as Australian Iron & Steel Ltd.'s Jetty, was completed in 1928, on land leased from the Department, to provide a direct shipping point for iron ore and other raw materials required by the Company in connection with the iron and steel industry. The jetty is 834-ft. long, with a berthing length of 323-ft., and carries 24-ft. at low water at a point 440-ft. from its outer end. Vessels berth only on the eastern side of this structure, which is equipped with an electric travelling transporter crane carrying a grab of 135 cu. ft. capacity. This crane is capable of lifting approximately 20 tons, including weight of grab, with an outreach of 51-ft. from centre of the outer leg of transporter tower to centre of grab. Direct rail connection is available from the jetty to the Company's works or to State railways, and inward materials are loaded direct into trucks on the jetty.

Moorings and Anchorage.—Moorings, with buoys attached, are laid in appropriate positions off each jetty to ensure the safe berthing of vessels, and ships' lines are run to these buoys by Departmental launches under the direction of the Berthing Master.

In the body of the harbour safe anchorage is available for vessels waiting to berth, and the central position of the anchorage is marked by the intersection of lines from two sets of shore beacons.

Up to the year 1930, a certain amount of difficulty was experienced in berthing vessels during heavy gales owing to range in the harbour. The occasions were comparatively rare, but during the heaviest storms, range sometimes made it necessary for the vessels to leave their berths. With the progress of the eastern breakwater, this range has been gradually reducing,

Port Kembla—continued

owing to the fact that the eastern breakwater is now tending to overlap the northern, thus protecting the harbour from the heaviest seas. During the last four years decrease in range in the harbour has been most marked, and during this period there is not one instance on record of a vessel having to leave berth for this reason.

Railway Facilities.—Up to the year 1916 railway access to Port Kembla was available only through Unanderra along the railway lines resumed from Colliery Companies, and all coal shipped at Port Kembla was brought in by this route. Truck storage space on these lines was limited, and in order to cope with the increased volume of traffic anticipated with the construction of No. 1 Coal Loading Jetty, railway access was improved by the construction, in 1916, of a direct line between Wollongong and Port Kembla. Just prior to this date, the balloon loop line in Port Kembla was completed as shown, with inward and outward sidings capable of storage of 300 loaded and 500 unloaded trucks respectively. This system, together with access lines to No. 4 Jetty, is at present in operation.

Total Expenditure

The total outlay by the Government on the development of Port Kembla and facilities from 1898 to 30th June, 1937, is as follows:—

Breakwaters	£802,869
Jetties	82,792
Haulage and shipping appliances	83,522
Land	81,865
	£1,051,048

This figure is exclusive of the capital cost of the Electricity Undertaking £561,375, Port Kambla-Wollongong Railway £50,859, and Port Kembla Water Supply £13,660.

The Port Kembla-Wollongong Railway and Port Kembla Water Supply, originally constructed by the Department, have passed to the control of the Railway Department and Metropolitan Water, Sewerage and Drainage Board respectively, and these bodies have been debited with the capital costs referred to above. The Electricity Supply was established as an undertaking with a separate capital debt in 1928, and is still controlled by the Department.

Proposed Wharfage

Proposed New No. 3 Jetty.—In order to deal effectively with the rapidly expanding trade at Port Kembla, the Government decided to replace the existing obsolete No. 3 High Level Jetty with a new jetty capable of being used either for shipment of coal or general cargo.

In accordance with this decision an Act of Parliament introduced by the author was assented to by the present Government in September, 1937, authorising the construction of the new jetty and appurtenances, including railway access and sidings at an estimated cost of £181,000.

The proposed jetty is to be of the low-level type, 14.6-ft. above L.W.O.S.T., and is to be 1,075-ft. long by 68-ft. wide. Vessels will be able to berth on either side over a berthing length of 750-ft., carrying from 42 to 24-ft. of water at L.W.O.S.T. The jetty will be fitted with four standard gauge rail tracks, and will be served by two electric luffing-jib travelling cranes of 18 tons capacity. Shunting on the jetty will be carried out by tractors, and rail tracks will be set flush with the deck.

The jetty has been designed to allow for the future construction of a small wharf and goods shed near the jetty base on the western side. This wharf will provide accommodation for coastal vessels when justified by the steamer traffic and trade of this class.

Contract plans for the jetty construction are nearing completion and tenders will be invited shortly for the construction of the jetty by contract. The new jetty will be situated slightly eastward of No. 3 Jetty and practically parallel to No. 4 Jetty as shown in the Supplement.

Construction has started on approaches at the base of the jetty, where a contract has been let for the earthworks required for access railway lines and sidings. The Department is constructing by day labour, stone approaches across the beach immediately at the rear of the jetty, using spoil stone from the breakwater quarry.

Inflammable Liquids Berth.—There is every indication of Oil Companies adopting Port Kembla as a distribution centre for the Illawarra district. The Commonwealth Oil Refineries, Limited, have purchased an area of land from the Department, and construction of storage tanks is well advanced. To meet the growing demand for handling facilities for inflammable liquids, approval has been given to construct an oil berth alongside the northern breakwater in position indicated in the Supplement. This berth, when completed, will permit tankers to discharge into pipe lines belonging to any of the companies which establish at the port.

It will be noted that for safety purposes the proposed oil berth will be placed on the northern side of the harbour, as far as possible from the centre of main shipping activity in the port.

Plans and specifications are now being completed with the object of calling tenders for the construction of this berth by contract.

Future Jetty Accommodation

In addition to the reconstruction of No. 3 Jetty and the erection of the inflammable liquids berth on the northern breakwater, the plan for the future, when trade conditions warrant, provides for the construction of a further general purposes jetty between No. 1 Coal Jetty and the northern breakwater, and the construction of a wharf alongside the northern breakwater inshore from the inflammable liquid berth, as shown in the Supplement.

With this ultimate construction in prospect, the Department has reserved certain strips of land for future rail access to the structures proposed. Provision for the necessary access lines and storage sidings is indicated along the western foreshore of the harbour and in the vicinity of Flinders Street.

The construction of Port Kembla harbour improvements, commenced under the direction of the late Mr. C. W. Darley, I.S.O., as Chief Engineer for Harbours and Rivers, has been subsequently continued under the late Mr. T. W. Keele, the late Mr. E. M. deBurgh and Mr. T. E. Burrows as Chief Engineers for Harbours and Rivers, and Mr. R. Vowell, Chief Engineer for Harbours, Roads and Bridges, Department of Public Works. At the present time, Mr. H. F. Searl, as Principal Engineer for Harbours and Rivers, Department of Works and Local Government, is responsible for the administration, design and construction of port improvements.

The construction of harbour improvements, shipping facilities and power-house have been carried out by the successive District Engineers of the Department stationed on the works.

The District Engineer also administers the port and the Electricity Supply Undertaking for the Minister, and acts as Harbour-master on behalf of the Maritime Services Board under the provision of the Harbour and Tonnage Rates Act.

The office of the present District Engineer and Manager, Mr. O. J. Moore, is at Port Kembla on the Wollongong-Port Kembla Main Road.

3. INDUSTRIAL AND COMMERCIAL DEVELOPMENT

Departmental Lands

The area of 496 acres originally resumed in 1900 in connection with harbour improvements, was found inadequate for the anticipated industrial expansion of the port, and in 1913 a further area of 1,470 acres was resumed, embracing all the available land between the Illawarra railway line and the coast, bounded by Wollongong on the north and the Five Islands road on the south. To this total area of 1,966 acres certain subsidiary areas have been added from time to time to meet quarry requirements, etc.

Growth of Industries

In 1908 the Electrolytic Refining and Smelting Company, the largest industry of its kind in the Empire, was established in Port Kembla on 52 acres of land purchased from the Department. At the same time a water supply was constructed at a cost of about £13,600, consisting of a concrete service reservoir, a balance reservoir at Mount Nebo, and about six miles of reticulation to serve industries and the growing township.

In 1917 Metal Manufacturers, Limited, purchased land from the Department adjacent to the Electrolytic Refining and Smelting Company, and established works for the manufacture of copper cables, tubes, etc. This company was followed, in about 1920, by Australian Fertilisers, Limited, established on part of the land owned by the Electrolytic Refining and Smelting Company.

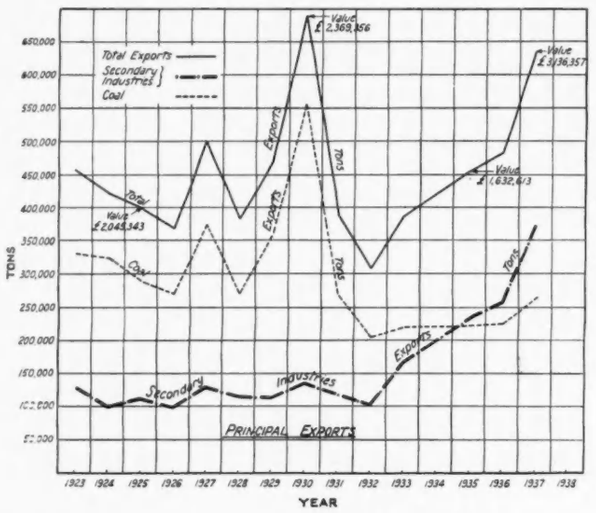
Other industries which originated about this time were the Ulladulla Silica and Firebrick Company (now Newbold Silica Firebrick Company) and the South Coast Timber and Trading Company.

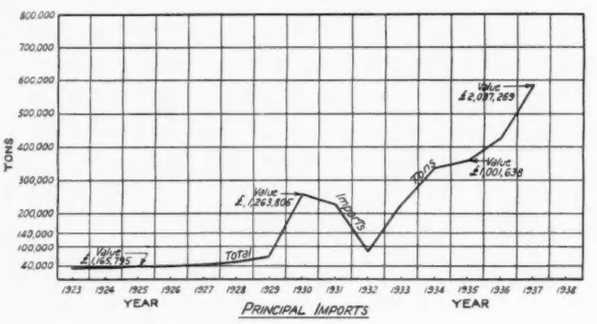
The industries enumerated above became firmly established, and expanded their activities up to the year 1927, when a further stage in the industrial development of the port was reached. This was brought about by the decision of the firm of Hoskins Iron and Steel, Limited, to transfer their ironworks from Lithgow to Port Kembla. This company, later formed into the company now known as Australian Iron and Steel, Ltd., entered into an agreement with the then Minister for Works (the late M. M. Flannery) in which the Government undertook to construct a railway 38¼ miles in length, from Moss Vale to Port Kembla, subject to the company expending within three years a sum of £750,000 on the construction of ironworks at Port Kembla. This agreement was ratified by Parliament in 1927, and in 1928 the establishment of ironworks and construction of the Moss Vale-Port Kembla Railway commenced. The railway was completed and opened for traffic in August, 1932, the capital cost being £1,494,000. The area on which the Australian Iron and Steel, Limited's works were first established was private land acquired by the company near Cringila Station, about 2½ miles from Port Kembla Harbour.

Port Kembla—continued

In common with other industries throughout the Commonwealth, those at Port Kembla suffered severely during the depression until the beginning of noticeable trade recovery in 1933.

In 1936 recovery of trade conditions was assured, and in that year Australian Iron and Steel, Ltd., decided on extensive expansion of their undertaking. To provide for the future growth of the industry and its various offshoots, the company purchased from the Government an area of 1,665 acres of land surrounding the Tom Thumb Lagoon. The agreement in connection with this sale provided, *inter alia*, that the company should, within five years, expend a sum of £1,000,000 on the erection of permanent and fixed improvements. This agreement was ratified by the Government in an Act of Parliament assented to in July, 1936.





VALUE OF TRADE £

	1924-1925	1929-1930	1934-1935	1936-1937
Exports £	(a) 2,045,343	(b) 2,369,356	1,632,613	3,136,357
Imports £	1,165,795	1,263,805	1,001,638	2,037,269
Totals	£ 3,211,138	£ 3,633,161	£ 2,634,251	£ 5,173,626

(a) Value 1924-25 inflated by approximately 12,000 tons of Manufactured Metals valued at £105 per ton & 3,000 tons of Copper at £70 per ton
(b) Abnormal year due to diversion of coal trade to Port Kembla by Newcastle coal strike

Trade at Port Kembla 1922-1937. Graphs showing Exports and Imports

With the purchase of this land and the company's decision to concentrate on Port Kembla, other allied industries were attracted to the port, and since 1936 it has been most satisfactory to note the advent of the following major industries, all of which have been established on lands either purchased or leased from the Department:—

Lysaght's Newcastle Works, Ltd. (Spring Hill Road).
Australian Iron and Steel, Ltd., Coke Ovens and By-products (off Flinders Street).
Armco (Aust.) Pty., Ltd. (inside Balloon Loop).
Commonwealth Oil Refineries, Limited (north of Power House).

In addition, Monier Industries, Limited, established a branch factory on land leased from the Department adjoining Australian Iron and Steel Company, Limited's jetty, and Australian Fertilisers, Limited, have acquired an additional area of land from the Department, and have erected thereon a new factory connected to their existing works by an overhead covered way. On land owned by the Australian Iron and Steel, Ltd., the Commonwealth Oxygen and Acetylene Co., Ltd., have established a branch factory.

As suggested by the Town Planning Committee, arrangements have been made to reserve certain areas of the remaining departmental land for subsidiary industries which have access to rail and sea transport, and will be sub-divided into blocks of from one to five acres. Such blocks should be eminently suitable for smaller industries.

Trade Statistics

The growth of industry in Port Kembla between 1922 and 1937, and particularly its rapid development in the last three years, can be traced in the graphs showing tonnage of principal exports and imports.

Exports

Before 1898, Port Kembla was an open roadstead shipping coal only, and in 1895 shipped 233,438 tons from the two private jetties then operating. In 1915 coal shipments had increased to 290,751 tons, the only major industry then existing being the Electrolytic Refining and Smelting Company. From 1922 to 1933 the graph of exports indicates a general decline in the coal trade, apart from the peak reached in 1930, owing to the Newcastle coal strike diverting trade to Port Kembla, but since 1934 there are distinct indications that coal traffic is again on the increase, although still below pre-depression levels. Secondary industries which, up to 1928, had amounted to less than half the tonnage of the coal trade, showed a marked rise in 1929. This rise was disturbed by the depression, but resumed its normal rate in 1932-33, until in 1934 the tonnage of secondary industries exceeded that of coal shipments.

In 1936-37 the graph shows tonnage of exports from secondary industries as exceeding coal exports by about 20%, and it is interesting to note that from 1928-29 to 1936-37 the tonnage exported by secondary industries had increased from 112,000 tons to 372,000 tons, or nearly 240%.

The table of values of exports demonstrates the extraordinary expansion of trade over the two years ended June, 1937, and figures available at present give every indication that this will continue.

Imports

The graph of Principal Imports shows similar tendencies to those exhibited in the case of exports. The total tonnage of imports which was gradually increasing up to 1928-29 suddenly assumed an upward trend in 1930, when iron ore was first shipped to the port.

This increase was also disturbed by the depression, but resumed its normal trend in 1932-33, until, from an annual tonnage of 70,800 in 1928-29 it reached 587,000 tons in 1936-37, an increase of over 700%.

It will be observed that the values of imports over the period covered by the graph do not reflect the percentage increase in tonnage. This is accounted for by the fact that prior to 1928 the comparatively small tonnage imported included copper ores, concentrates and other metals of much higher value than the iron ores which account mainly for the more recent increase in tonnages imported.

Another gauge of the expansion of trade is given by the Railway Department's returns of goods (excluding coal) shipped in and out of Port Kembla, and is summarised as follows:—

Rail Traffic at Port Kembla

Goods only—Tons hauled

Goods Direction	1930	1935	1937
	Tons	Tons	Tons
Outwards	54,447	47,657	214,855
Inwards	20,590	25,885	115,571
Totals	75,037	83,545	330,426

These figures show an increase of 300% in goods shipped by rail over the two years ended June, 1937.

4. LOCAL GOVERNMENT WORKS

The town of Port Kembla and the surrounding district in which industrial development is taking place with such rapidity are all within the boundaries of the Central Illawarra Shire, which has an area of approximately 130 sq. miles. As indicating the phenomenal increase in building activity in the Shire to December, 1937, the following official figures are interesting:—

Description	1931		1933		1935		1937	
	No.	Value £	No.	Value £	No.	Value £	No.	Value £
Residences only (Brick and weatherboard)	11	3,958	34	13,480	105	63,132	335	197,598
Shops and Industrial buildings	1	500	—	—	5	2,279	49	178,411
Totals ...	12	4,458	34	13,480	110	65,411	384	376,009

From 1931 to 1937 the value of buildings erected has increased in the ratio of approximately one to eighty-five, and from 1935 to 1937 in the ratio of nearly one to six.

Port Kembla—continued

The Port Kembla and Environs Planning Committee, appointed by the Government in 1936 (see section (5), Town Planning), recommended the construction of roads, footpaths, drainage and other civic improvements on a definite plan designed to cope with the growing industrial and residential districts surrounding the port. This work, which was obviously a function of the Local Governing Authority, was on such a scale as to be beyond the financial resources of the Shire Council, even with the prospect of later recovery by means of the enhanced rating capabilities of the area, and the Government came to the conclusion that the Council could not reasonably be expected to carry out the whole of the designed improvements without substantial assistance financially.

The Local Government (Further Amendment) Act, 1935, provides the machinery for assisting Councils in carrying out development works with Government assistance. Such assistance is given both by direct grant and also by payment of so much of the interest on Council's loans as is necessary to limit the interest payable by Council to 3½%. Since 1936 the Council has expended an amount of approximately £153,000 on development works, towards which the Government has contributed £100,000 by way of direct grant, and in addition has contributed £11,000 towards repayment of principal and interest in respect of loans raised by the Council. At the present time a further scheme of development works, estimated to cost £75,000, is receiving consideration by the Government, and if approved, will probably be carried out on similar lines.

Amongst the major works constructed by the Council with financial assistance from the Government are Port Kembla Stormwater Drainage £50,000, Arterial Roads £20,000, Olympic Standard Swimming Pool £16,600, the road from Port Kembla to Lake Illawarra entrance £12,000, and a bridge over the entrance of Lake Illawarra, which, together with approaches, cost approximately £27,500. The road from Port Kembla to Lake Illawarra, and the bridge near the lake entrance, were constructed with a view to giving a more direct route between the metropolitan area, the Wollongong-Port Kembla district, and the tourist towns further south.

Prior to the construction of this road traffic proceeding south from Port Kembla, to Shell Harbour, for instance, was obliged to go westward about five miles to Unanderra, thence via the Princes Highway, around the western shores of Lake Illawarra to Shell Harbour, a total distance of 18 miles. By the new route this distance will be reduced to eight miles.

Port Kembla which, before the construction of this road, was practically at a dead end as far as road access is concerned, will now be accessible to the whole of the surrounding district by a direct route which may ultimately become the main South Coast highway.

The Central Illawarra Shire Council, in addition to the activities mentioned above, controls an electricity undertaking, purchasing its power in bulk from the Department's power station at Port Kembla and distributing for domestic and industrial purposes within the Shire. Departmental assistance has also been given to the Council from time to time in connection with extensions of their reticulation to rural consumers.

A sewerage scheme for the whole of Port Kembla township has been investigated and preliminary estimates have been prepared. Negotiations are now in progress between the Department and the Council as to the best method of financing and constructing this scheme.

5. TOWN PLANNING

The growth of population in Port Kembla and environs, following on the increase in industry in 1936, resulted in intense building activity to house the growing population. At the same time, it was seen that there was a danger of industrial undertakings springing up in hitherto residential areas and *vice versa*.

To avoid this danger the Government, in 1936, appointed a committee of experts to plan the district, the personnel of this committee being as follows:—

Chairman: Mr. H. B. Mathews, B.A. (former Surveyor-General). Members: Messrs. V. V. W. Williams (Works and Local Government Department); R. H. Stokes (Metropolitan Water, Sewerage and Drainage Board); R. J. K. Harris, A.R.I.B.A. (Lecturer in Town Planning, Sydney University); V. G. Rush, F.C.I.V. (Valuer-General's Department); J. Farram, F.C.A. (Aust.), (Public Accountant); B. C. Griffiths, B.A., B.A.I. (Shire Engineer, Central Illawarra Shire).

The Committee were asked to draw up a plan of the road system, water and sewerage services, drainage, electricity reticulation and other local government services; to plan the area into residential, industrial and commercial districts; to draw up a plan for the communal services, such as hospitals, schools, and such like public buildings; to suggest a lay-out for parks and public reserves, baths and other recreational facilities; to report on the probable cost of such works and services and the most suitable method of financing them; and to suggest an organisation for the construction of public (Government) assets.

The Committee has carried out special local inspections, has been in close consultation and co-operation with the Central Illawarra Shire Council and Wollongong Council, as well as with public bodies, various Government departments, managers of local industrial works, and owners of private estates.

The work already completed has resulted in an interim report which enabled the Government to render financial assistance to the Council for arterial roads, for minor roads, and for drainage works.

For the arterial and minor roads the area considered was that part of the district between the South Coast Railway and the ocean, and between Wollongong on the north and Lake Illawarra on the south.

A design is now being prepared for the zoning of the district to provide generally for industrial, residential and factory areas.

Other matters being dealt with include an exhaustive investigation of the practicability of a comprehensive sewerage proposal; and of reclamation reserves, parks and school requirements.

The work carried out by the Committee has also facilitated the preparation of satisfactory designs for sub-division of some of the larger private estates in the vicinity of the Port and Lake Illawarra.

6. FUTURE EXPANSION

Port Kembla Harbour works, as at present planned, are now practically complete, and, apart from periodic maintenance to storm damage, it is not anticipated further construction will be required.

Wharfage and shipping facilities have been planned to accommodate a greater volume of shipping than is indicated for many years to come, and the existing facilities will be augmented as planned when the increase in trade warrants their extension.

In addition, the inter-connection of the Port Kembla Electricity Supply with Burrinjuck Hydro-electric Scheme, together with the projected increase in capacity of the Port Kembla Station, will enable the Government to continue offering favourable rates for power to industrial consumers, and this will be further assured as additional industries develop.

For the establishment of new industries and the expansion of those existing there still remain considerable areas of private land and a limited area of Government lands in the vicinity of the port within easy reach of the coalfields and with access to rail and sea transport.

There is every indication that Port Kembla, with its practically unlimited coal resources, cheap electric power, abundant water supply and accessibility to rail and ocean transport, has prospects of great industrial development, and it is on these indications that the Government of New South Wales has formulated its policy of augmenting the harbour facilities and the Electricity Undertaking to meet anticipated trade demands.

The Paper concluded with an acknowledgment of assistance received from various sources.

The Liege Exhibition

There is a special propriety in calling attention to the forthcoming Exhibition at Liège, Belgium, which is to be opened in May and remain open till November.

Dedicated to the subject of "Water," the Exhibition will demonstrate the important part played by the liquid element in the life of mankind and in human communities. Two principal objects are envisaged. First, to show how man in his struggle for existence defends himself from water or makes use of it. Secondly, to indicate the more general applications of water to communal life.

In the first division will be shown how scientists have studied water and it properties, how the engineer designs and constructs in order to convey and impound it, so as to utilise its power in rivers, in canals and in machines, to prevent it causing damage and to utilise its special qualities for industrial purposes, such as refrigeration. An important section will be reserved to navigation, both marine and fluvial, to fishery and to aquiculture.

In the second division will be displayed the part played by water in human health and sanitation, comfort and decoration, travel, sport and fashion.

The Exhibition, which signalises the completion of the great Belgian inland waterway, the Albert Canal, will be erected on the two banks of the River Meuse, at the junction of the river with the new canal. It will comprise a hundred pavilions, including those of the Sea, Navigation, Civil Engineering, Naval Construction, etc.

In a later issue, it is proposed to give a description of the Albert Canal, which connects the industrial region of Liège with the maritime port of Antwerp by a shorter route and more capacious waterway than has hitherto been available. Vessels of 2,000 tons burden will be able to reach Liège from London, Normandy and Scandinavia.

Extensions at the Port of Genoa

*The New Graving Dock in Course of Construction**

By Commendatore A. ALBERTAZZI, Chief Engineer of the Autonomous Consortium of the Port

IN the issue of June, 1937, were set out the fundamental principles adopted for the construction and equipment of the new graving dock (No. 4) of the Port of Genoa.

As was stated at the conclusion of this exposition, the work has been continued briskly, without pause, without rest and without impatience; and the numerous difficulties met with have been faced and overcome; whence the great work, notwithstanding some delay in the initial provisions, is now at the point of completion.

Foundation Depths

In the same account, attention had already been directed to the remarkable depth reached in the caissons sunk up to that time, and that because the first layers of rock, which it was possible to remove by means of drilling operations, did not offer the degree of impermeability which was essential for a basin of the "drained area" type, such as that under construction. Nevertheless, while it was anticipated that the caissons would have to be bedded into the rock on an average to the depth of about one metre, actually the sinking was on the average from 4 to 5 metres (13 to 16-ft.), and reached finally to 7 metres (23-ft.), after encountering the first layers of rock, without reckoning that in some caissons, in order to avoid further sinking, excavation was continued in the loose material and in the layers of clay interposed between those of the rock, also under the cutting edge of the caisson itself, in rendering watertight the sides of the excavation with suitable walls of concrete. In certain caissons, it was in this way possible to reach the depth of as much as 6 metres (19½-ft.) below the cutting edge (see photograph).

Graving Dock No. 4. Broken Rock in Fourth Compartment

Thus it is that in some places levels of about 27.50 metres (90-ft.) below zero datum were attained.

This brought about some disturbance of the hypothesis made in regard to the provisional stability of the sides during the period in which their construction having been completed and the interior of the compartment having been pumped out, it would be necessary to remove the internal loose material in order to penetrate as far as the first stratum of rock and to execute the construction of the floor in cement concrete.

In fact, in such calculations it was anticipated that the plane of support of the various caissons would not be lower than −19.50 (64-ft.); and only on such conditions would it have been possible to determine that sufficient support between two strutted caissons, opposite one another, would be afforded by a beam of reinforced concrete placed at the level of about −1.00 (3.28-ft.). But, having considerably exceeded the assumption of the said calculations about the depth of foundation of the caissons, it became necessary to take some precautionary measures; and it was decided to execute a counterfort between two strutted caissons opposite one another, about the level of the support on the rock, by the construction of walling of cement concrete, executed under compressed air in movable caissons, with which, having extracted the loose material and the less trustworthy layers of rock, the walling was executed in the interior of the compartment, of the breadth of the strutted caisson and not less, in any case, than 4 metres (13-ft.) and connecting at the base two strutted caissons as far as the level of about −16.00 (52½-ft.).

From the foregoing, it will be readily understood that the work of sinking the side caissons and of the construction of the outer gate platform by the application of the floating gate, not including the other accessory works, has been prolonged considerably beyond the estimate, so much so that it was completed only on the 4th April, 1938.

Caisson Connection

An interesting feature has been that of the construction of the connections between the caissons, details of which were not yet completely settled at the time of the preceding article. For the construction of these connections, the method was as follows:

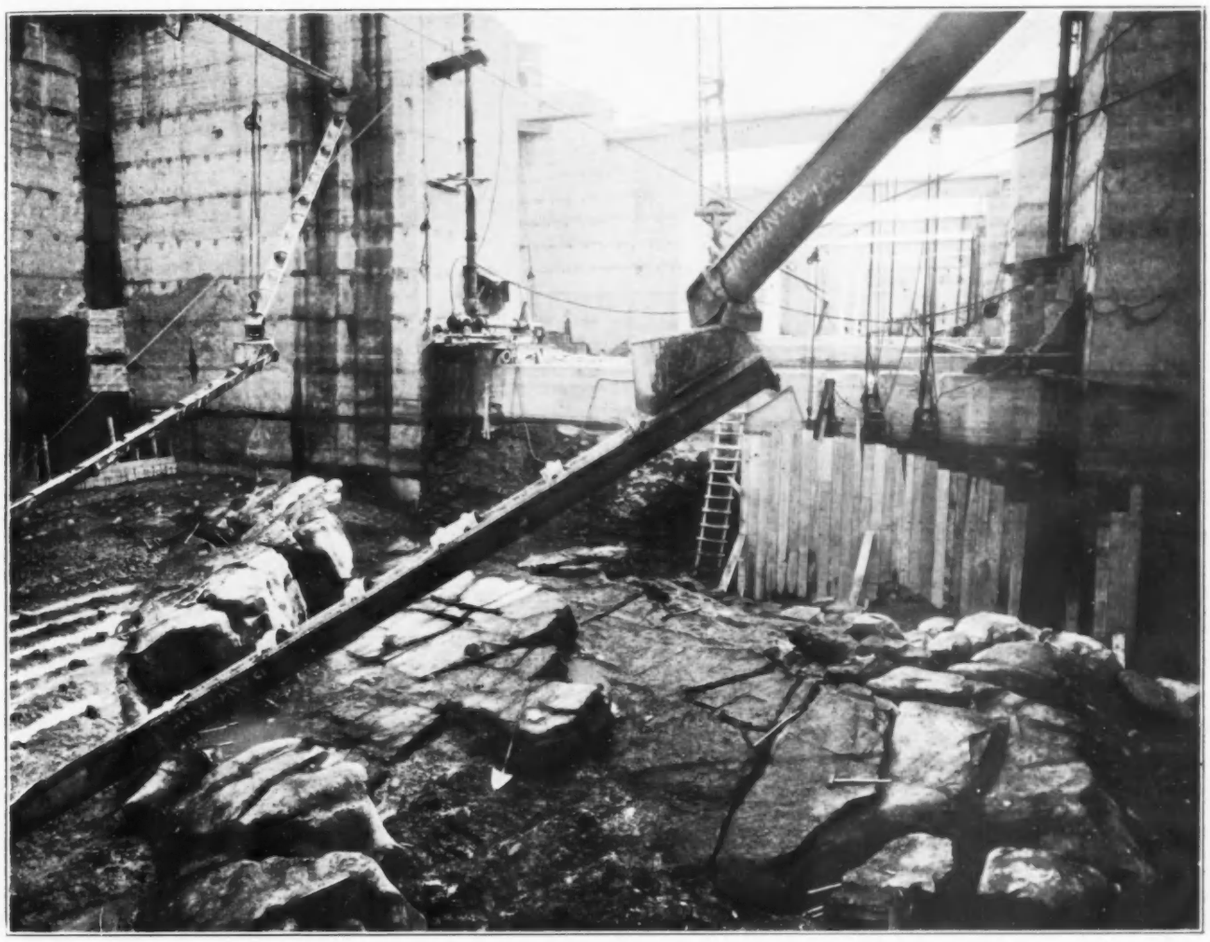
The spaces between two adjacent caissons left a width of from .8 to 1.00 metres (2-ft. 6-in. to 3-ft.), with the possibility of working therein between benching practised in the lateral external walls of the caissons, and additional sides were afforded when two caissons were brought together and slabs of highly resistant cement concrete were introduced by means of a diving bell. Such slabs of the height of about a metre and of the thickness of about 25 c.m. (10-ins.) were superimposed, the one on the other on two sides of the joint, in order to form a provisional closure of the joint itself, which it was arranged also to grout with quick-setting cement. In this way was formed a working chamber of variable width from 0.80 metres to 1.00 metres (2-ft. 6-in. to 3-ft.), and about 5.50 metres (17-ft.) in length, which was covered above with a slab of reinforced concrete of high resistance, on which was placed a lock for entry and exit to and from the compressed air. Before closing the said chamber by means of the upper slab, it was completely filled with broken rock of light weight. From the lock compressed air was passed into the chamber where, excavating by degrees the dislocated rock and completing the closure on two sides by means of accurate plastering of the slab, and by subsequent construction of strengthening walls in cement concrete of the thickness of 50 centimetres (19-in.), it was possible to expel the water under air pressure, descending gradually to the foot of the joint. Simultaneously, having previously prepared the side walls of the caissons by scraping and chipping, jets of cement grout could be played to a height of about 3 metres (10-ft.) each time, to fill the space between the two caissons, leaving only a well for descent to the bottom. Thus it was possible to reach the rock, removing the broken and less impermeable part, down to the foundation of the two adjacent caissons, with the necessity also of some sinking somewhat below this, always exercising the precaution of filling in thoroughly with cement concrete. Finally, the access well itself was filled and the connection completed.

The work of forming the joints between the caissons, notwithstanding its peculiar difficulty, was carried on with very great regularity; the joints themselves, as will be seen later, were made completely impermeable and if, by chance, infiltration appeared sometimes underneath the joints; as also under the foundation of the caissons, this was due to the weakness in the first layers of rock, which frequently exhibited underlying veins of clay and loose material, the existence of which could not be foreseen, and which, being disturbed by the water pressure, allowed the water to pass through. But even this inconvenience was effectively dealt with, as will be seen later.

* Translated from the Italian.

Developments at the Port of Genoa—continued

Having completed, as stated, on the 4th April last, the construction of the side walls, including the respective joints between them, and also the outer gate recess, the next step was the cross strutting by means of beams of reinforced concrete between two opposite caissons at the level of −1; then, having set the floating gate in the outer recess and having commenced the pumping out, the process was continued as far as the uncovering of the loose material in the interior of the chamber, which, through the previous construction of counterfort walling between the caissons was divided into eleven compartments, of which the nine central compartments had dimensions of 20 metres by 45.60 metres (65-ft. by 150-ft.).



Graving Dock No. 4. Interior of Chamber, showing fissured rock

Infiltration Difficulties

An initial difficulty presented itself at once in the appearance of heavy infiltrations amounting to a thousand cubic metres per hour (roughly 220,000 gallons), through various fissures in the rock, but more particularly at the joints and under the foundation of the caissons. As previously stated, it was not easy to foresee these inconveniences, if not in evidence during the sinking of the caissons by reason of bad material, where the first strata of rock showed occasional intrusions of beds of clay, sand and miscellaneous material; naturally, attempts were made to overcome this difficulty by deepening the foundations of the caissons themselves, but in some cases the layer of rock concealed so completely the underlying material that it was not possible to detect it. Still, having encountered these losses, means were at once taken to arrest them. If necessary, the smaller infiltrations were collected by means of drain conduits (according to judgment based on the construction of the basin); for the five larger losses, excavation was made under compressed air in a working chamber left in the floor concrete alongside the caissons below the thickness which it was necessary to add to the caissons themselves for the purpose of completing the side walls of the dock. The concrete for this additional thickness was raised above the chamber, before working in compressed air, in such a way that there was on the chamber itself sufficient weight to counterbalance the thrust of the compressed air. Through an appropriate shaft with its respective lock, it was possible to penetrate into the working chamber, displacing the compressed air, at low pressure at first, since it was not practicable to close all the exits, and then increasing it by degrees, when, by excavation and tracing the fissures through which the water came (and whence during the work the compressed air escaped), these latter could be stopped with walls of cement concrete, until almost complete watertightness was obtained. Then it was possible to fill in the working chamber with cement concrete and to mature it under compressed air so that the passage of water was definitely arrested.

The existence of the infiltrations rendered the work difficult, on account of the number of appliances which were necessary for pumping out; all the means prepared in this respect proved insufficient and, notwithstanding later additions, were scarcely equal to establishing definite equilibrium between the infiltration and the emptying; and for that reason, with the foregoing appliances, it was not possible to do more than check the more important losses.

Another difficulty, easily foreseeable, as was said above, during the sinking of the side caissons, was the greater depth which had to be reached for the foundation of the floor in respect to that contemplated; seeing that, as was indeed the case, it was not essential to reach impermeable rock, it was only necessary to remove the loose material clay and sand which would have been easily transportable by the infiltrations of water, closing in this way the voids in the interior of the floor. Thus it was, that while the sinking of the side caissons attained the average level of −22.50 metres (74-ft.), that of the floor foundation came to about the level of −20.00 metres (65-ft.). This greater depth constituted also a certain difficulty for the reason that it necessitated almost always the provision of a double lift for the infiltration water.

Notwithstanding this, the work of excavation in the interior of the chamber and the construction of the mass of the floor in concrete, the whole executed in free air, progressed industriously towards its conclusion, with its essential object of receiving the first ship in the basin itself. The excavation was started towards the end of May, 1938: it was fully carried out within the month of October, and the construction of the floor and the strengthening of the side walls were finished during the month of November.

At the end of this month, there remained only the flooring of the basin, the removal of the upper strutting and the execution of finishing touches, the whole of which could be completed within three months.

Theory, Construction and Use of Sextant Charts

By L. M. BOSTWICK and OSCAR ROSENZWEIG.*

In making hydrographic surveys in areas too remote from land to employ transits for location of positions of a boat, from which soundings are taken, sextants are usually employed. Each position of the boat is determined by measuring with two sextants a pair of simultaneous angles subtended by three known points, which are usually fixed objects on shore. Each position of the boat, as fixed by the two observed angles, may theoretically be computed by solving a " three point " problem. Needless to say, such procedure is not practical, as it would involve long and elaborate computations. The practical method generally used in fixing locations is by plotting with a †three-arm protractor, on which the two observed angles are set off, and the position determined at the centre of the protractor when the three arms are made to coincide with the objects as plotted on a chart.

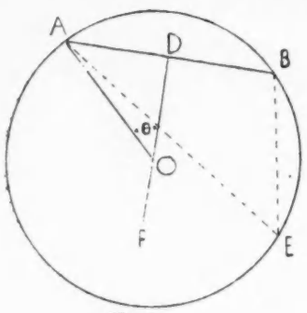


Fig. 1

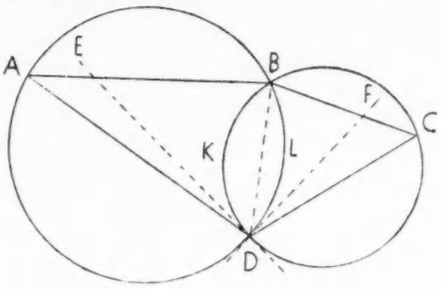


Fig. 2

In cases where a large number of positions are to be located in a limited area, it was found more expedient and more accurate to construct, for a given set of three objects, a so-called " Sextant Chart," which is a graphical method of solving " three point " problems by means of intersecting angle-arcs. The use of sextant charts becomes indispensable in cases where the distance from the boat to the objects is too great for the use of a three-arm protractor; it also permits the immediate plotting of observed locations of soundings in the field, as taken.

The basic principle involved in constructing a sextant chart will be demonstrated and explained.

Let A and B on the drawing (Fig. 1) represent two of the three fixed points. Draw AB and let DF be the perpendicular bisector of AB. With O, any point on the bisector, as a centre, and OA as a radius, draw circumference, and denote ∠ AOD by θ Since any chord of a circle subtends the same angle at all points of the circumference lying on the same side of the cord, it follows that arc AEB is the locus of points at which a given ∠ E is subtended by AB. ∠ = ∠ E, as any inscribed angle is equal to half of a central angle subtending the same arc. From right triangle AOD, we have

$$OD = AD. \cot\theta$$

Assigning various values to θ, usually at uniform intervals, the corresponding values of OD, the distances of the centres from D for the various values of θ assigned are computed and plotted. With the centres thus located, and with OA = OB as a radius, a set of angle-arcs is drawn in. Another set of angle-arcs, representing the loci of vertices of angles between B and C is similarly computed and drawn. It is evident, that a pair of angles observed from any point will determine one and only one point on the sextant chart, and conversely, any point on the sextant chart represents a pair of sextant angles and a definite point in the area covered by the chart. If a point is so situated that it is on the circumference passing through the three fixed points, the location becomes indeterminate, as any point on this circumference would satisfy the pair of angles to the objects.

Assuming the sextant angles to be correctly measured, the accuracy of a plotted position depends largely on the selection of the three fixed objects. Poor locations result when the objects are so selected that the values of both angles change at a relatively low rate. Such condition would indicate the position to be near the circle passing through the three objects, and is, of course, to be avoided. The most accurate results are attained when the objects are so selected in relation to the area to be covered by the sextant chart, that the value of either subtended angle changes rapidly with a relatively slight change in position, and when the values of these angles are between 30° and 130°.

The most satisfactory sextant chart locations from the standpoint of rapidity of plotting and accuracy of plotted position are those in which the angle-arcs intersect at 90°. However, very satisfactory charts may be constructed when the available objects will not permit the fulfilment of the above condition. In general, it may be stated that the more the angle formed by the intersection of the angle-arcs deviates from 90°, the more difficult the plotting of the position, and the less accurate the determination. As the angle approaches 0° (or 180°), the point approaches the circle through the three objects, and the location is practically indeterminate.

For a given set of three objects, a relation between the angle formed by any two intersecting arcs on a sextant chart and angles that can readily be measured will now be established.

Let A, B and C be the three sextant objects and D a point whose position is to be determined. (Fig. 2). Evidently, the intersection of the two circumferences, the one passing through A, B, D and the other through B, C, D, will determine on a sextant chart the position of D. The angle at which arcs BKD and BLD cross at D is by definition ∠ EDF, formed by the tangents to the two circles at this point. Draw the common chord ED. Then ∠ BDE = ∠ C, since both are measured by one-half the arc BKD. Likewise, ∠ BDF = ∠ A, and hence ∠ EDF = ∠ 2A + ∠ C. Since ∠ A + ∠ ABC + ∠ C + ∠ ADC = 360°, as the sum of the angles of a quadrilateral it follows that

$$\angle EDF + \angle ABC + \angle ADC = 360°$$

$$\text{or } \angle EDF = 360° - \angle ABC - \angle ADC.$$

Since ABC for a given set of sextant objects is fixed, 360° − ∠ ABC is also known, and the angle at which the two angle-arcs intersect for any given point D is, therefore, the difference between this constant angle (360° − ∠ ABC) and the angle at D, measured between the two end objects A and C. If ∠ ADC is supplementary to ∠ ABC, that is, if ∠ ADC = 180° − ∠ ABC, ∠ EDF must be 180°, and the position of point D becomes indeterminate. It also follows that the two angle-arcs will intersect at the ideal angle of 90° when ∠ ADC + ∠ ABC = 270°.

As the merit of any sextant chart depends to a large extent on the angles at which the two sets of arcs mutually intersect, the relation just derived may be used as a means of selecting the set of objects that would yield the most desirable intersection angles. This is of particular value in selecting and testing locations of " sextant " towers that are to be erected in cases where natural sextant objects are not available.

The channel and selected objects, viz., Bombay Sextant, Cole and Duck Creek Light (see Chart), having been previously plotted by their rectangular co-ordinates on an "outline" chart of the river,* the limiting values of the subtended angles required to cover the desired area, are measured by a protractor from this chart. Next, the stationing of each sextant object on (Liston Range) centre line and the corresponding normal distances from the objects to the centre line were computed, as illustrated on Fig. 3.

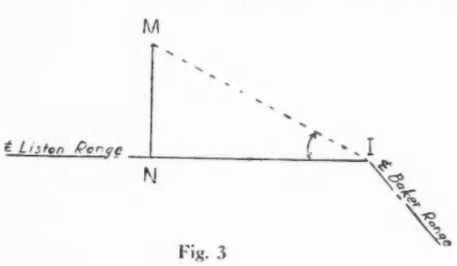


Fig. 3

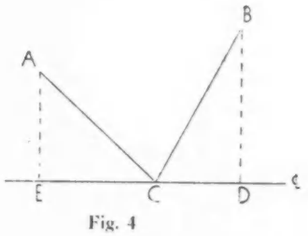


Fig. 4

Let M be one of the sextant objects whose stationing and normal distance is to be determined. From the known co-ordinates of I, the intersection of Liston and Baker Ranges, and M, the sextant object, the distance and azimuth of MI are computed and value of ∠ MIN, the included angle, determined as the difference of the azimuths of IM and centre line of range. Then

$$M = IM. \sin \angle MIN$$

$$IN = IM. \cos \angle MIN$$

As the stationing of I is known, the stationing of N can be determined.

* United States Engineer Office, Philadelphia, U.S.A. The Paper, which has been abridged, is that alluded to in the letter from Mr. L. D. Shuman in the March issue of this Journal.

† " Station Pointer " in English nomenclature.

* A portion of the Delaware River Ship Channel (plan not incorporated here) was selected for the purpose of a demonstration. Liston Range and Baker Range are consecutive "axes" of the channel.

Theory, Construction and Use of Sextant Charts—continued

The stationings and normal distances of the mid-points of the chords connecting Bombay Sextant with Cole and Cole with Duck Creek Light were derived as the arithmetical means of the corresponding values of the points connected. Using the computed stationings and normal distances, the three sextant objects, as well as the two mid-points were plotted.

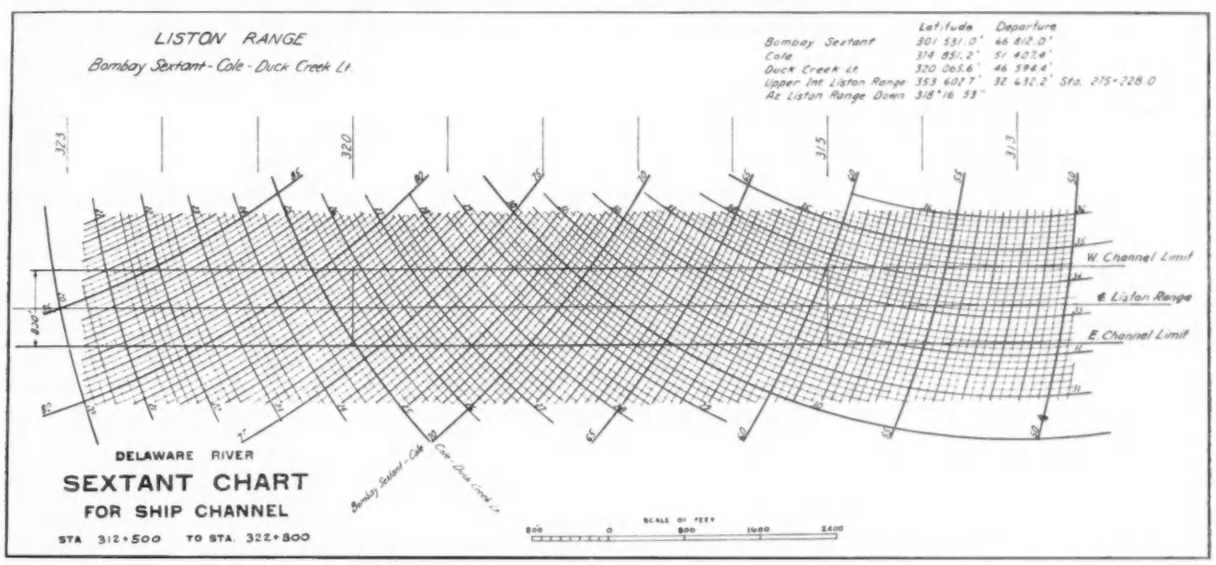
From the known co-ordinates of the sextant objects, the azimuths and distances between the objects were computed and used as a check on the computations and plotting.

Check angles for testing the accuracy of the construction of the chart were computed for four even thousand-foot stations on the Liston centre line. The centre line of the range, side lines of the channel and the stationing were then adjusted on the chart to conform closely with the computed values of the check angles.

From the given co-ordinates of Liston-Baker intersection and the azimuth of the range, the co-ordinates of the four centre line points were first computed, and then the azimuths from these points to the three sextant objects were derived. The value of each sextant angle at a given centre line point is then readily obtained from the known azimuths of the directions from this point to the respective sextant objects.

triangular scale, 1″ = 800′, is placed on this line and weighted, and 5,000-foot stations are pricked off using a reading glass and a fine needle point. The scale is shifted as needed until stations from 310 + 000 to 335 + 000 have been pricked, after which the stationing of the sextant objects and construction lines are pricked off on the centre line. Through stationing 316 + 647,, which is that of the middle object (Cole), a perpendicular is erected by construction with the beam compass, using two or more sets of intersecting arcs, the intersections being pricked and the perpendicular carefully drawn with a fine hard lead.

The normal distance of Cole is then scaled from the centre line along this perpendicular and the position of Cole is lightly pricked; the normal distances of the other two objects and the mid-points (of their connecting chords) are also laid off to scale on the perpendicular through Cole. These normal distances are then transferred with beam compass, by describing short arcs, using as centres the respective stationing points on the channel centre line. Then, using as centres the points marked off on the perpendicular through Cole, and as radii the corresponding distances along the centre line from the channel stationing of Cole to the stationings of the other two objects and mid-points, arcs are swung. The intersections of these arcs with the ones



Another method for computing check angles is by making use of the stationing and normal distances of the sextant objects, and is as illustrated on Fig. 4.

Let A and B be two sextant objects whose stationing and normal distances are known and let C be a given channel stationing on the centre line. Required to compute ∠ ACB. Since ∠ ACB + (∠ ACE + ∠ BCD = 180°, and (∠ A + ∠ B) + (∠ ACE + ∠ BCD) = 180°), it follows that ∠ ACB = ∠ A + ∠ B. BD and CD are known, the first being the normal distance of B and the second the difference of stationing of C and D; therefore, ∠ B can be computed (tan B = $\frac{CB}{BD}$). ∠ A can similarly be determined (tan A = $\frac{CE}{AE}$). Hence ∠ ACB can be computed.

The distance along the line of centres is then computed for each arc that is to be swung on the chart. This work is most readily accomplished by using a computing machine and a table of natural trigonometric functions, or a card with the natural cotangents listed.

The cotangent of any angle exceeding 90° may be expressed in terms of one less than 90° by using the relation that the function of any angle equals the same function of its supplement, and all computations for the angle-arcs will, therefore, be limited to acute angles. As the cot 90° = 0, the centre for the 90° angle arc is the mid-point of the chord, that is the intersection of the line of centres with the chord connecting the corresponding objects; for angles less than 90° the computed distances for the centres are measured from this mid-point toward the area to be covered by the chart, and for angles exceeding 90° away from it. The arc for any angle over 90° will be swung in with the same radius as the supplement angle (acute).

The sextant chart is laid out in pencil on a well-seasoned piece of good quality, smooth surfaced, mounted paper, preferably "Paragon 120." The scale selected for this particular chart was one inch to 800 feet. The actual work of construction proceeds as follows:—

A fine line, representing Liston Centre Line, is drawn on the paper along a straight edge with an 8H pencil. A 24″ white edge

previously swung from the centre line are carefully pricked off, thus fixing the positions of the end objects and the two mid-points. Their positions may be checked by comparing the two diagonals of the various rectangles formed by the respective points as above constructed.

The chord between the left-hand object (Bombay Sextant) and the middle object (Cole) is now drawn, and if the construction has been accurately done this chord will, of course, pass through its mid-point. In like manner, the chord drawn between the middle object and the right-hand object (Duck Creek Light) should pass through the plotted mid-point.

Next, the two lines for the centres of the two sets of angle-arcs are constructed by using the standard geometric method for drawing perpendicular bisectors. If the construction has been accurately done, each perpendicular bisector will pass through the plotted mid-point of the chord bisected and through the point pricked on Liston centre line at the stationing computed.

For the next step, the triangular scale is placed and weighted along the line of centres, with the zero of the scale at the mid-point of the chord. The distances, computed for the centre of each angle-arc to be swung, are scaled and pricked exactly on the finely-drawn line. Unless these centres are pricked exactly on the line, the resulting arcs will show a non-uniform spacing. The centres for the second set of arcs are similarly pricked off on the other line of centres. In pricking the centres, each degree should have an identifying mark placed opposite it and each five degrees should have the value of the angle noted in pencil.

The next step is to draw the angle-arcs on the layout in pencil, the first ones to be drawn being those that will permit a check of the work, by comparison with the computed check angles. The first arc to be drawn is for the 83° angle between Bombay Sextant and Cole, the next arc for 80° 40′ between the same objects and so on for the other check angles, after which the arcs are drawn for the check angles between Cole and Duck Creek Light. Having pricked the positions of Stations 322 + 000—319 + 000, etc., on Liston Range Centre Line, the radial distance is scaled at the centre line, from the 82° 40′ arc to the 83° arc, and from the 82° 40′ arc to the prick mark for station 322 + 000, which lies between these arcs. These proportionate scaled distances are used to compute the angular distance

Theory, Construction and Use of Sextant Charts—continued

between the 82° 40′ arc and the centre line station 322 + 000, thus furnishing a check on the computed angle at station 322 + 000 between Bombay Sextant and Cole. A similar procedure is followed for the other check angles. If the scaled values of the check angles are not in close agreement with the computed values, a mistake in construction or computation is indicated, and must be corrected. If the agreement is close, but differs by a scaleable amount, new points which will fit the check angles are pricked. These new points are used in fixing the position of the centre line and stationing on the tracing.

The arcs are drawn by placing the steel pivot of the beam compass in the centre pricked for the angle-arc to be drawn, and adjusting the pencil on the other end of the beam until it passes through the point pricked for the middle object, and with this as a radius, the arc is described through the area to be covered by the chart. This is done for each degree until all degree arcs have been drawn in pencil, the value of each 5-degree arc being noted in pencil at one end of the arc. The same procedure is followed in drawing the arcs for the right-hand angles, except that for this case every 30-minute arc is drawn instead of every degree.

As a check on the construction of the arcs may be used the fact that the arc of a given angle passes on the line of centres through the centre for the arc of half the angle. The truth of this statement can be demonstrated as follows:—(See Fig. 5).

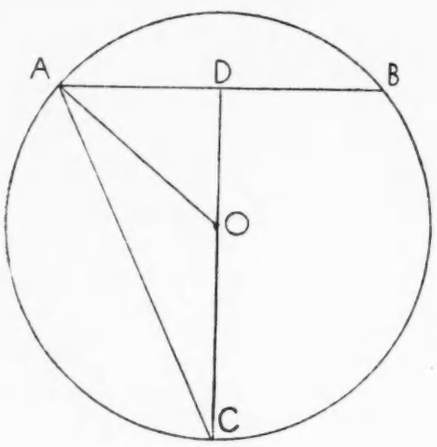


Fig. 5

Let AB be the chord connecting the two sextant objects and DC the perpendicular bisector of AB. The circumference drawn is, evidently, the locus for ∠ AOD. ∠ C = 1/2 ∠ AOD, since an inscribed angle is half of a central angle subtending the same arc, and, as point C is the centre of an arc drawn for ∠ C, it follows that the arc corresponding to ∠ AOD passes through the centre of the arc corresponding to 1/2 ∠ AOD.

Having drawn in all the angle-arcs in pencil, a piece of tracing cloth, which has been cut from the roll several hours earlier, is now placed over the arcs and secured to the mounted paper with Scotch tape. The centre line of Liston Range is traced lightly in pencil.

To trace the angle-arcs, the pencil is removed from the beam compass and the pen put in its place. A suitable thickness of line for the degree arcs having been selected, the steel pivot of the beam compass is placed in the degree centre, the corresponding pencilled arc is found and the radius of the compass adjusted to fit this arc. The radius should be tried at both ends of the pencilled arc and checked against the middle object to make sure that the centre being used is the correct one for the arc to be swung. The arc is then traced in black ink on the cloth for the desired length, and the pivot of the compass is moved to the centre for the next degree and the radius for the corresponding arc found as before. This is repeated until all the degree arcs for both sets of angles have been traced.

The 30-minute arcs in the right-hand set of angles are next traced, using a suitable thickness of line. The remaining arcs to be inked on the tracing are the 20 and 40-minute arcs for the left-hand angles and the 10, 20, 40 and 50-minute arcs for the right-hand angles, the centres for which were pricked but the arcs not swung in pencil.

The position for these arcs on the tracing is fixed by dividing the distance between degree arcs into three equal parts for the 20 and 40-minute arcs, and the distance from degree arc to 30-minute arc in three equal parts for 10, 20 and 40 and 50-minute arcs. These divisions are indicated with light pencil marks on the tracing.

The thickness of line for these arcs is decided on, and the arcs are drawn in ink on the tracing, using the pivot of the beam compass in the pricked centres, computed for these arcs and the radii as determined by the corresponding pencil-marked divisions of the degree or half degree. This completes the tracing of the arcs. The centre line and edges of channel and the stationing are inked on the tracing. The numbering of the degrees and the channel stationing is lettered on the tracing, with a tabulation showing co-ordinates of the objects, and the co-ordinate and stationing of a point on Liston Range with the azimuth of the range. A small title and the scale completes the tracing.

It should be mentioned that once the construction is started, it should be completed as quickly as possible to avoid shrinkage and expansion of the sheet due to changes of temperature and humidity. The inking of all the arcs on the tracing should be done in one day. It requires considerable skill on the part of the draughtsman to accomplish satisfactory results.

The charts may be constructed to any scale within the limit fixed by the space available for laying out the area to be covered by angle-arcs, the lines of arc centres, the middle object, and also the two mid-points.

In fixing the scale of the sextant chart or the size of layout, it is well to remember that in cases where the maximum value of the angle-arcs is less than 90°, the plotting of the mid-point is not essential, as centres along the line of centres may be plotted from a computed point falling within the limits of the layout.

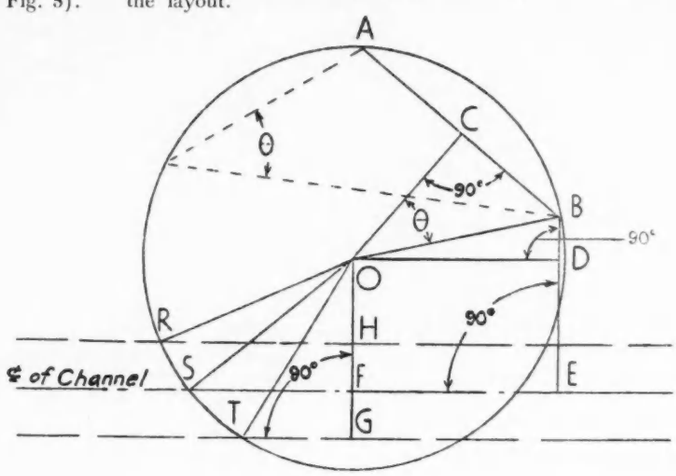


Fig. 6

If, in preparing a sextant chart for a channel, it is desired to use a scale too large to permit the drawing of the arcs with the beam compass, the intersection of the various arcs with the centre line and sides of the channel may be computed and plotted, and the curves then drawn by holding a steel straight-edge "on edge," and bending it to fit the three points. If greater accuracy is desired, a chord may be drawn between the plotted side-line points, and a sufficient number of intermediate points plotted by the method of middle ordinates to permit the use of an irregular curve.

The intersection of arcs with the channel lines are computed thus:

Given the length and azimuth of AB (line connecting two sextant objects) and the azimuth of the channel (see Fig. 6). From the arc-angle and the half-chord CB compute radius OB. Also compute stationing and normal distance of B. Draw OD parallel to channel. As the azimuth CO is known (differing by 90° from AB), also the azimuth of OD (being the same as the channel), ∠ COD is determined. Hence OD and BD may be computed from right triangle OBD, in which OB is known and ∠ BOD, being equal to ∠ COD - ∠ θ is also known.

FO = DE = BE - BD, whence HO and GO may be found from the known channel dimensions. Then in the right triangles ORH, OSF and OTG, we may compute RH, SF and TG, which, in turn added to OD and the stationing of E, yield the respective stationing of R, S and T.

A more expedient method for getting up a large scale sextant chart is by constructing one on a smaller scale, and then enlarging it to the desired scale through photostating. Generally speaking, a photostat enlargement is not as accurate as the original; however, very satisfactory charts have resulted from a double enlargement, and usable charts from an enlargement to four times the construction scale.

When constructing a chart on a smaller scale than the finished drawing, the thickness of the lines should be reduced so as not to be too heavy when enlarged.

Editorial Note: The detail computations for the Sextant Chart shown on the previous page are omitted. The area covered by the chart is a portion of the Delaware River Ship Channel.

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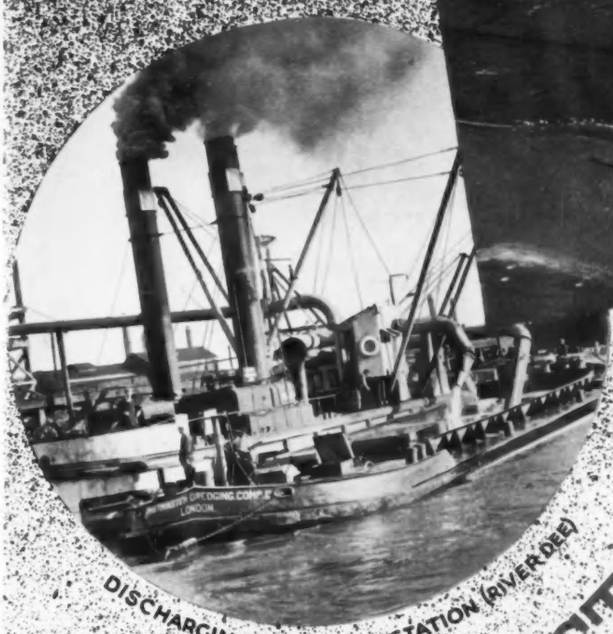
AERIAL VIEW OF RECLAMATION SITE



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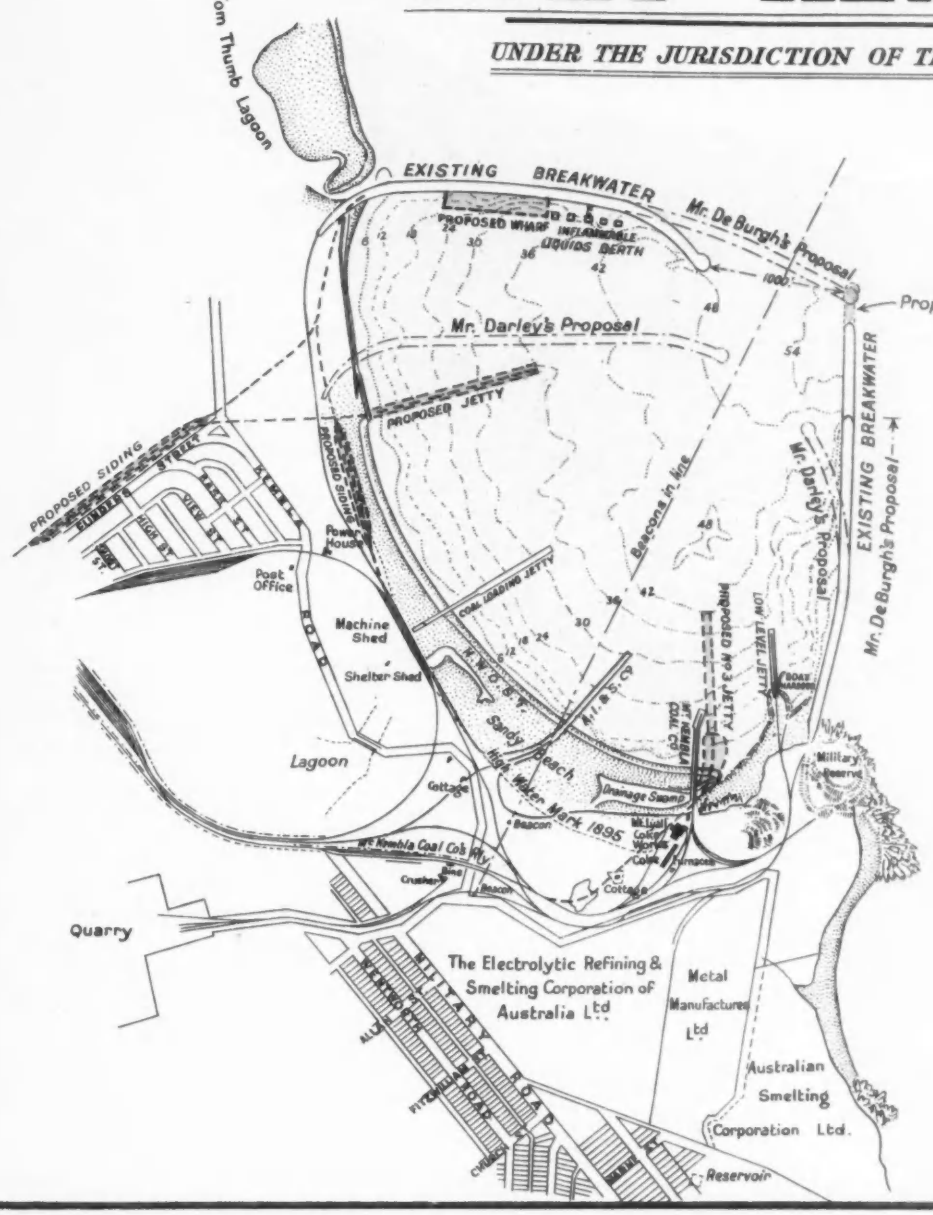
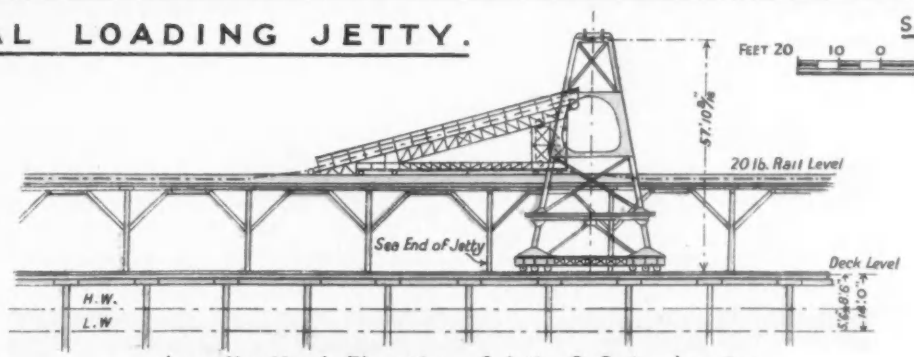


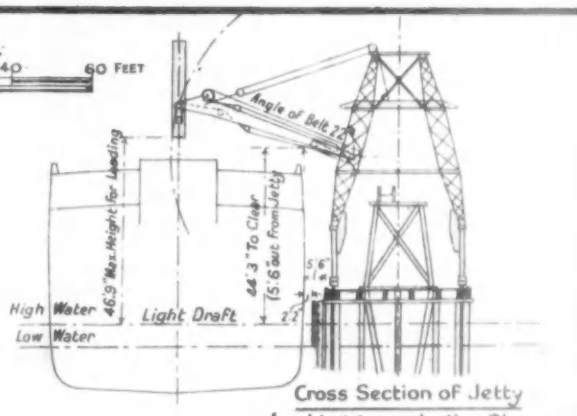
NOTE.

Extension of Existing Breakwater coloured RED
Contours of Soundings reduced to L.W.O.S.T.
Proposed Jetties coloured RED.

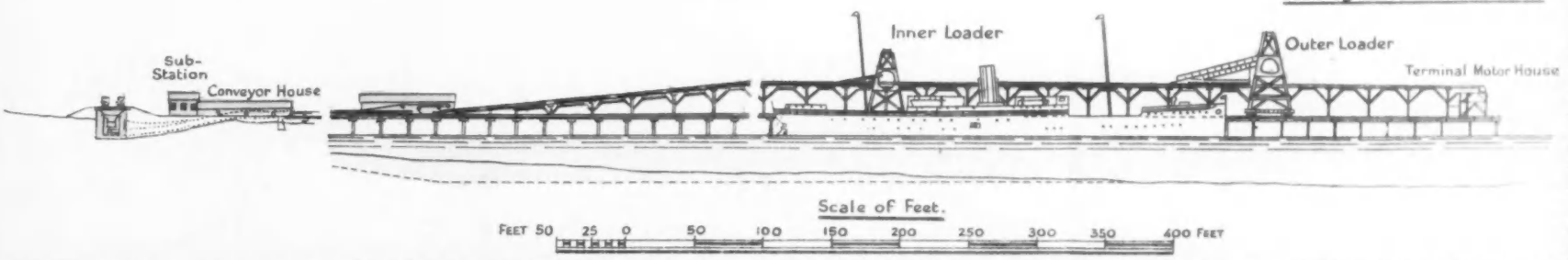
COAL LOADING JETTY.



Longitudinal Elevation of Jetty & Outer Loader.



Cross Section of Jetty
Looking towards the Shore.



Scale of Feet.
FEET 50 25 0 50 100 150 200 250 300 350 400 FEET

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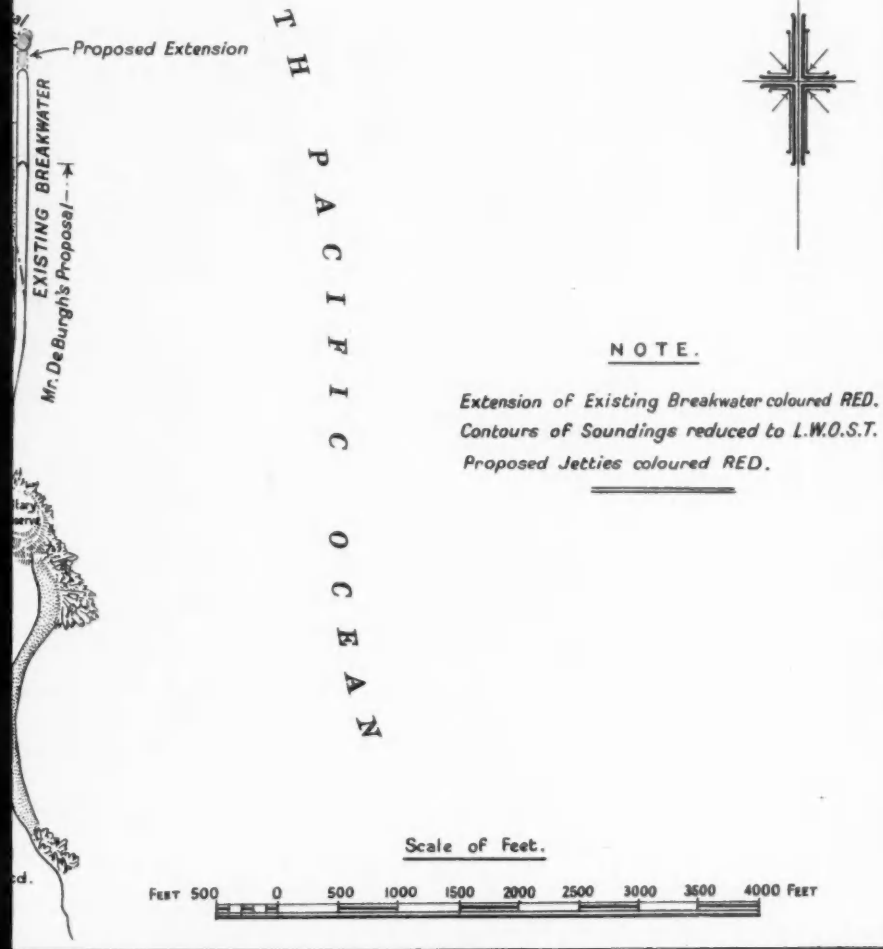
Proposed Extension
EXISTING BREAKWATER
Mr. De Burgh's Proposal
SOUTH PACIFIC OCEAN
N
NOTE.
Extension of Existing Breakwater coloured RED.
Contours of Soundings reduced to L.W.O.S.T.
Proposed Jetties coloured RED.
Scale of Feet.
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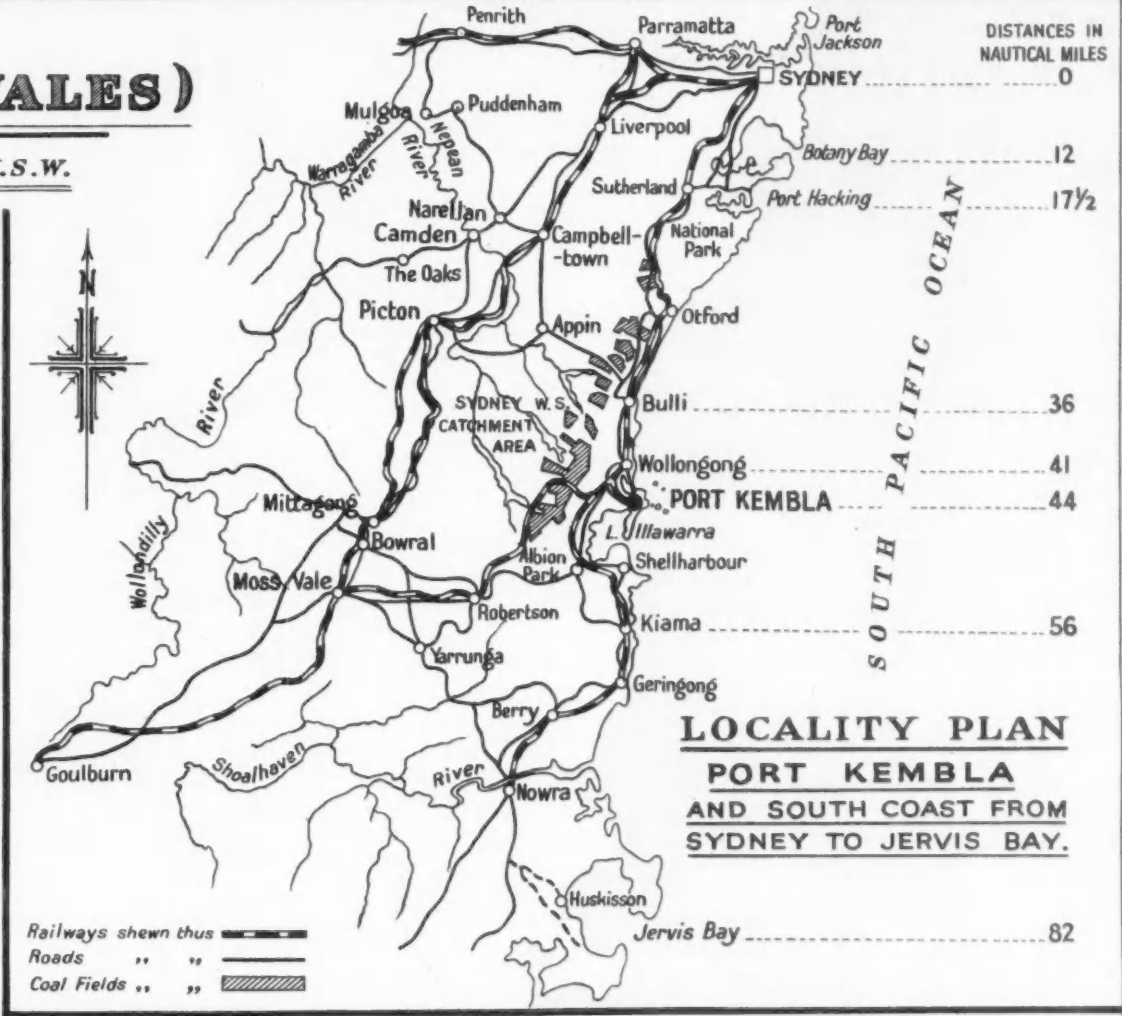

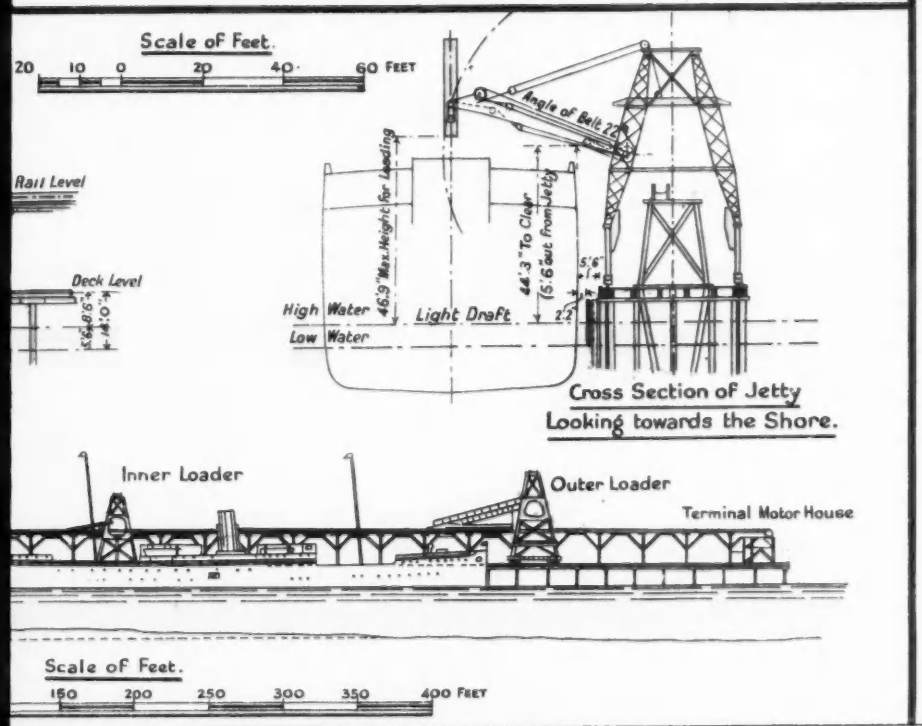

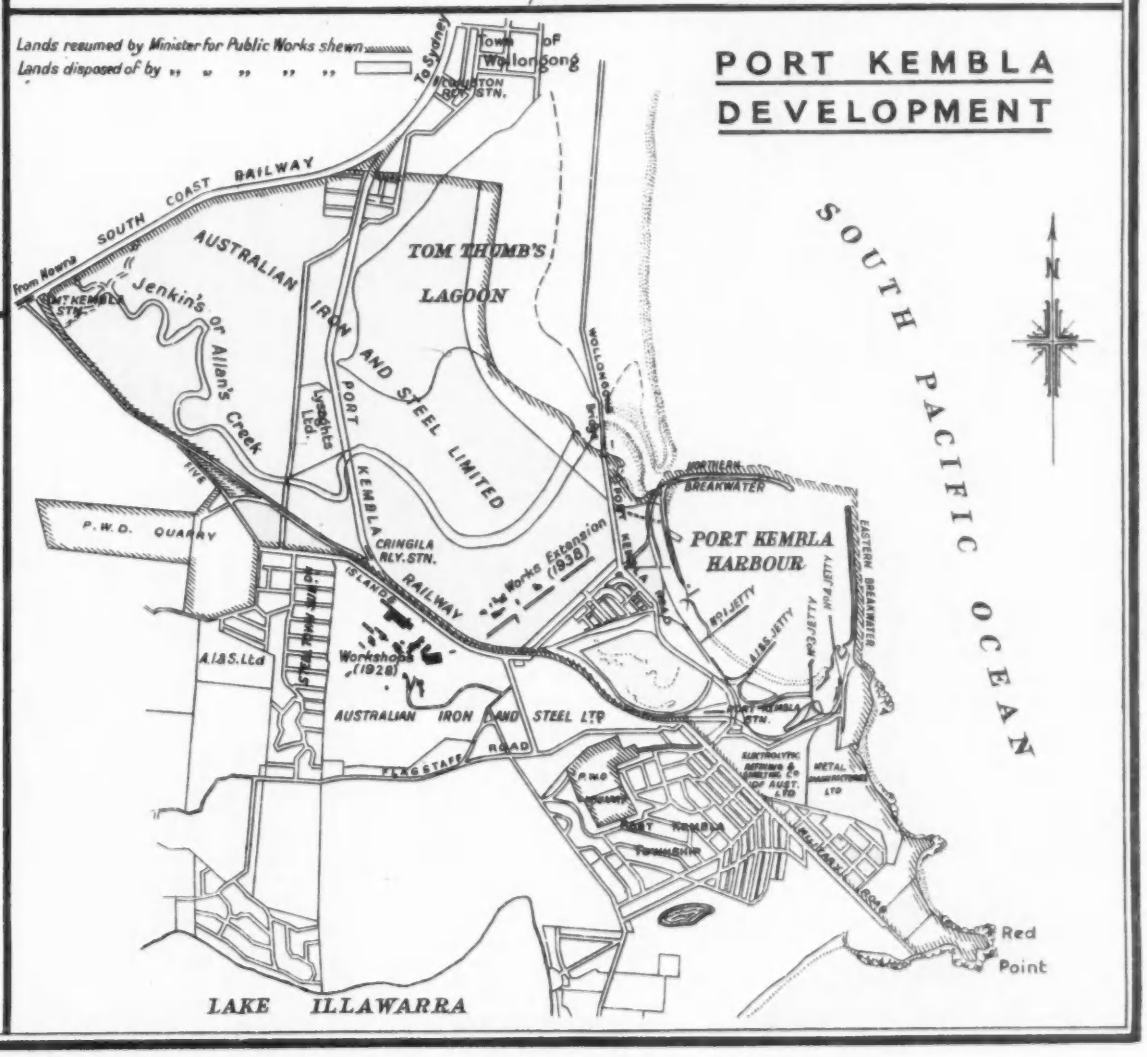

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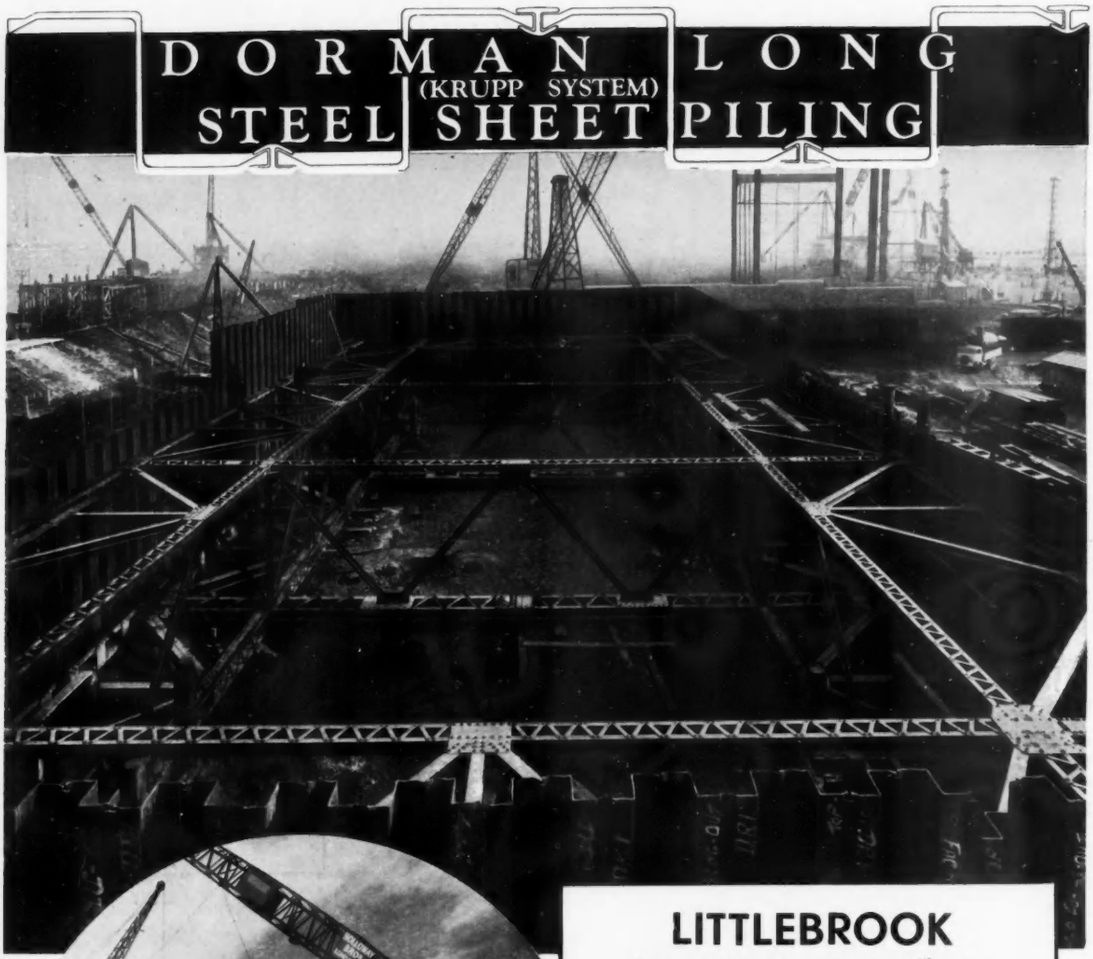

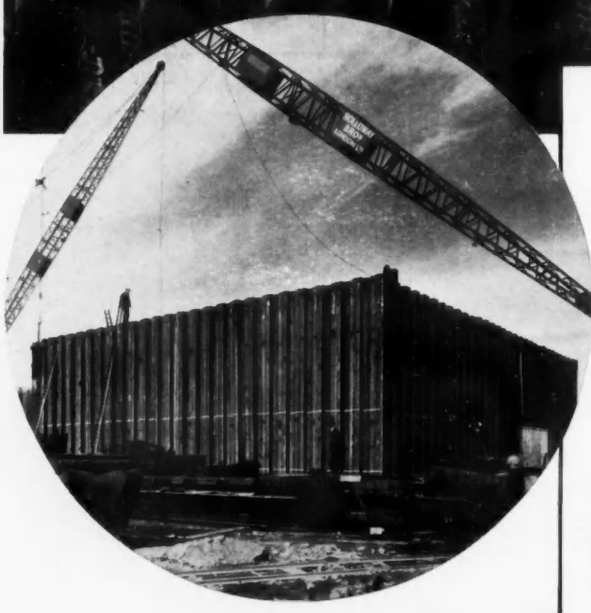

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DORMAN LONG

Notes of the Month

New Quay at Bergen.

A proposal to construct a new quay at Bergen Harbour at an estimated cost of 165,000 kr. has been approved by the Bergen Port Authority. It is understood that the work will be put in hand almost immediately, and the quay is expected to be completed during the summer of 1940.

Proposed Extensions at Gdynia.

The Gdynia Harbour Board have under consideration the further development of the harbour during the next three years. The principal objects of the scheme are an extension of the passenger quay, the deepening of the harbour, and the construction of a special quay for the discharge of ore. It is understood that various foreign financial groups are interested in financing the scheme, which is now being examined in detail.

Extensions contemplated at the Port of Aalborg.

Plans are under consideration for extensive improvements at the Port of Aalborg, and it is thought that the time is now opportune for the establishment of a free port. Attention has also been drawn to the excellent conditions east of the port where there are sites with deep water alongside and railway facilities which are admirably suited for port expansion and for the establishment of new industrial enterprises.

Proposed Jetty at Filey.

At a recent meeting of the Filey Urban Council, attention was drawn to the need of a harbour to safeguard the fishermen, who had difficult launching conditions. It was suggested that, as a preliminary measure, a jetty should be constructed, and after discussion, it was decided that a full Council Meeting should be held in the near future to consider the matter in greater detail.

New Vessels for the Harwich-Flushing Service.

Following the launching of the first of two new vessels in January last, the second vessel for the Harwich-Flushing service was launched by H.R.H. Prince Bernhard on Saturday, 25th March, at Flushing. The new ships will be approximately 4,100 tons gross with a speed of 23 knots, and will perform the daily service between Harwich and Flushing in connection with the L.N.E.R. boat trains to and from London. They will have a carrying capacity of 1,800 passengers, and also 60,000 cu. ft. of cargo space and accommodation for 24 motor cars. Both vessels are expected to be in service during the summer.

Harbour Improvements at Alexandria.

Plans have been prepared for improving the harbour at Alexandria at an estimated cost of £3,000,000. The scheme includes the construction of a new dry dock for the use of naval vessels, and the creation of additional quays and also the construction of a petroleum basin for tankers. The oil tanks at present on the harbour side are to be removed to the south of the railway, and will be linked up to the quay by a pipeline. Also, as the existing channel is of insufficient depth to permit the passage of the largest warships, the main entrance channel is to be deepened to 42-ft.

Severe Tidal Damage in Lancashire.

A heavy gale, experienced in England on March 8th, did considerable damage on the North West coast. At Fleetwood, a sea defence wall, which cost £150,000 to construct twelve years ago, was breached for a length of 322-ft., and many acres of farm land were flooded. Morecambe Sea Promenade also suffered severely, and at Blackpool the streets and hotels were invaded by the tide. The Crosby Lightship, at the entrance to the Mersey Estuary, broke adrift from her moorings, and the crew had to be rescued by a lifeboat. The floating landing stage at Liverpool was swept by waves and the cross-river ferry service conducted with difficulty.

Floating Docks for Stockholm.

The 1,000-ton floating dock under construction at Stockholm, which will be completed in the near future, will be the first all-welded dock in Sweden. It will be stationed at the Port of Stockholm to meet the demand for docking facilities at the Hammarbyvarvet. It is also reported that the Finance Committee of the Stockholm Harbour Board is considering a project for the acquisition of a further large floating dock, and will in all probability grant the sum of 1,300,000 kr. for the establishment for this purpose of a semi-municipal company under the style of A.-B Stockholms Flytdocka. It is expected that the Government will grant a further 600,000 kr. for improving docking facilities. The total cost of the dock is estimated at 2,150,000 kr.

New Wharf at Dalmuir, Glasgow.

The Clyde Navigation Trust has approved a proposal by H.M. Office of Works to construct on the former shipyard land at Dalmuir, a basin with a timber wharf on the west side 300-ft. long to be used for berthing a Post Office cable ship.

Cochin Harbour Development.

The programme of development works at the harbour of Cochin, which has been in progress over a period of nearly twenty years, is approaching completion. One of the final items, the bridge linking Willingdon Island, on which the port accommodation is located, with the mainland, is expected to be put into commission during the coming summer.

New Icebreaker for Canadian Ports.

The latest icebreaker, in course of construction for Canadian harbours, will be unique in that it will serve a duel purpose, as in addition to ice-breaking, the vessel will be used for inspection and maintenance of the St. Lawrence River Ship Channel, and will also help to victualise lighthouses, re-check the position of buoys and watch channel trends.

Tenders Invited for New Berths at Melbourne.

The Melbourne Harbour Trust Commissioners recently invited tenders for the construction of the first six of the 21 berths for overseas shipping at the Appleton Dock. The whole scheme of harbour improvements involves an expenditure of approximately £3,500,000, and includes, in addition to the berths at Appleton Dock, the reconstruction of sheds at Victoria Dock and North Wharf, and the erection of two more 3-ton electric cranes at Station Pier. The work will be put in hand within the next few months.

Dock Improvements at Fleetwood and Barrow.

Improvements, estimated to cost about £124,000, are being carried out at Fleetwood and Barrow by the London, Midland & Scottish Railway. At Fleetwood, part of the south-end corner of the quay is being reconstructed, two pairs of lock gates are being renewed and a new reinforced concrete slipway is being built. At Barrow, a steel sheet pile quay is being constructed at Buccleuch Dock, the gates of Ramsden Dock are being renewed, and the construction of concrete dolphins, and a reinforced concrete runway and footway is in progress in the harbour yard.

Safeguarding Approaches to Port of Karachi.

A proposal to instal a uniform system of buoyage and to erect a beacon light has been submitted to the Central Government by the Karachi Port Trust. The suggestion is that the breakwater light shall be changed to red, and the existing green and red light buoys shall be reversed by interchanging their coloured screens. The five gas buoys at present in use will be fitted with conical cages, so as to be easily distinguished in daylight. The starboard buoys will be painted black and the port buoys red. It is also proposed to erect a flashing beacon light of the Aga type on the summit of Tyster rocks, to act as a guide to the entrance and to enable a vessel to ascertain its position when approaching the port at night. It is estimated the scheme will cost about Rs. 6,000.

Southwold Harbour Works.

The Southwold Town Council are much exercised about certain improvements at present in hand at the harbour under the direction of the East Suffolk Rivers Catchment Board, and in February they made representations to the Ministry of Transport and the Ministry of Agriculture "with reference to the extremely unsatisfactory state of affairs at the harbour, and more particularly with regard to the manner in which the works have been designed and carried out." The Council contend that certain alterations to the original plan have been introduced without their approval or concurrence. The letter from the Town Clerk states that, "according to the original design and plans, the new North Pier was to be erected on the site of the old North Pier, but it was found impossible to drive the piles on the site of the existing North Pier, and consequently the powers that be, without in any way consulting the Town Council, gave instructions for the new North Pier to be constructed to the north of the old pier, thereby considerably increasing the width of the harbour mouth, the consequence being that with certain winds and tides the inside of the harbour and for some distance up the river is like the open sea, and no boat, ship, or anything else, can lay alongside the quay wall without the greatest danger of receiving serious damage." The matter is still the subject of correspondence between the Town Council, the Catchment Board and the Ministries.

*Improvements at the Royal Docks, Port of London Authority**

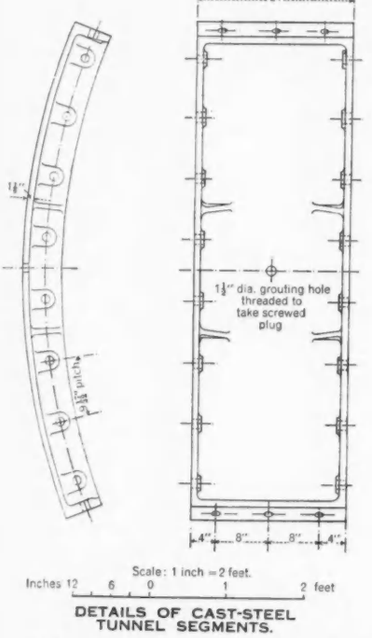
By RALPH ROBSON LIDDELL, M.Inst.C.E.

(Continued from page 143)

New South Quay and No. 1 Shed

Although the sheds and buildings on the south side of the Victoria Dock were rebuilt on modern lines with ample road and rail facilities after the disastrous Silvertown explosion in January, 1917, the only usable quay was that in front of Sheds Nos. 2 and 3 (Fig. 1). This quay, built in 1892, was about 1,000-ft. long, and consisted of several rows of timber piles supporting steel joists and troughing covered with concrete decking. The width varied from 59 to 67-ft., and had a sharp gradient up to the level of the shed floors, aggravated by the deterioration of the timber campsheeting retaining the ground in front of the new sheds; it was inconvenient for working and, moreover, was not strong enough to take the weight of modern cranes.

FIG: 7.



DETAILS OF CAST-STEEL TUNNEL SEGMENTS.

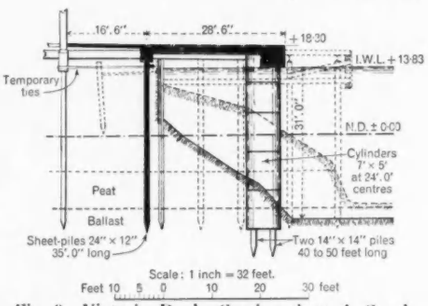


Fig. 9 Victoria Dock: Section through South Quay at No. 2 Shed

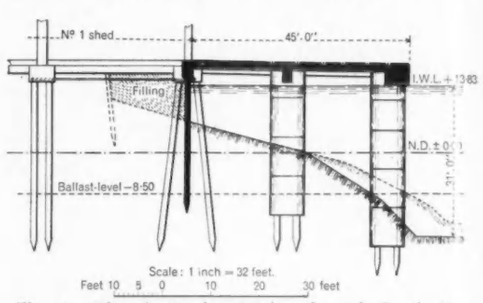
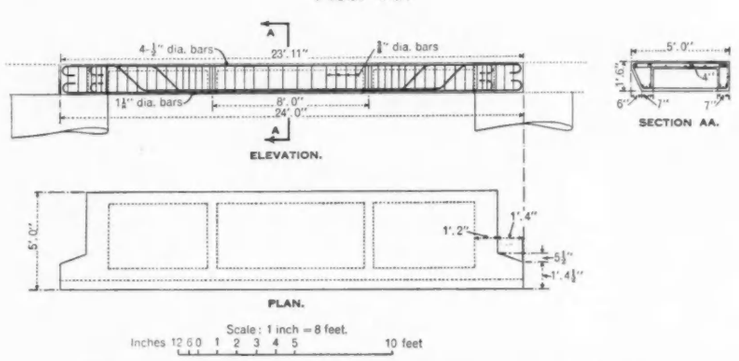


Fig. 11. Victoria Dock: Section through South Quay at No. 1 Shed

FIGS: 10.



DETAILS OF TYPICAL PRE-CAST BEAM UNDER COPING BEAM.

The Port Authority let a contract in August, 1935, (a) for the replacement of this quay in reinforced concrete, (b) for the removal of the solid jetty separating the south side of the basin from the main dock, (c) for the extension of the concrete quay across the basin to a total length of 1,750-ft., and (d) for the foundations for a new shed.

The work started at the east end of No. 3 shed by the excavation of a trench down to the tie-rods of the old campsheeting which were cut as the driving of the 24-in. by 12-in. concrete sheet-piles advanced; the latter were held by steel channel walings tied back by 1½-in. rods to the existing shed-columns during the construction of the new quay.

A 5-ton steam crane running on a track laid along the outer portion of the existing quay served for the construction of this length (Fig. 9). Holes were cut in the decking, piles drawn, and the cylinders sunk through steel guide frames from level benchings formed at −5.00 N.D. by grabbing. All material was delivered by water to a floating mixer-plant and, after piling and hearting the cylinders, the inner portion of the existing quay was removed. Pre-cast soffit beams (Figs. 10) were then placed between the cylinders spaced at 24-ft. centres, on which the shuttering for the coping beams was erected. The steel of the main transverse beams at 24-ft. centres was continued through the sheet-pile capping beam and lap-welded on to the bars of the anchor tie-beams. These were provided at each column when the two sheds were constructed in 1921 to the design of Sir Cyril Kirkpatrick, Past-President Inst. C.E., the Authority's Chief Engineer from 1913 to 1924.

During the demolition and removal of " M " jetty by blasting and dredging, a temporary staging was erected across the water area towards No. 2 Shed, the foundation piles for the new shed were driven, and the quay commenced from the west end. This consisted of the two rows of cylinders and continuous sheet-piling shown in Fig. 11. The latter was driven first and temporarily supported by steel walings at water-level and tied back by 1½-in. diameter bars to the base of the shed foundations. A 16-in. raking pile was then driven on either side of the sheeting at the 24-ft. centres of the shed-columns and the area behind the sheeting filled in. The front cylinders followed by the back cylinders were then sunk, piled, and hearted. The cylinders sunk in pits from a level of +7.00 N.D. at the extreme west end proved troublesome, and it was necessary to link the rings together. Pre-cast soffit beams were used for both the coping and the longitudinal beams; the main transverse beams were pre-cast up to the underside of the deck-slab with rods left projecting for welding to the land anchor-ties, and the intermediate transverse beams were supported from the main beams and concreted to the underside of deck at the same time as the coping, intermediate longitudinal, and sheet-pile capping beams. All transverse beams were formed with tapered sides to form a 2-in. rebate for 3-in. thick pre-cast deck-slab soffits reinforced with high-tensile steel, these being suspended from travelling trusses during the depositing and setting of the deck-slab.

The adoption of pre-cast soffit-beams not only overcame the difficulty of erecting and striking shuttering near the water-level, but prevented the pinning down of laden barges beneath the deep coping beams. The ballast-level fell from 8-ft. 6-in. below N.D. at the west end to 16-ft. below N.D. at the east end. The sheet-piles ranged from 28-ft. to 38-ft. long, and the front cylinder piles from 40-ft. to 50-ft. long. A 5-in. fresh-water main was hung under the quay with hydrants placed on cylinder tops at 96-ft. centres. Access manholes were formed in the deck at 216-ft. centres, and two pitch-pine rafts were provided and moored under the decking for the maintenance of the main.

A 13-ft. 6-in. gauge crane-track was laid the full length of the quay with slots, 2-in. wide and 3-in. deep, across the quay at about 60-ft. intervals to take the trailing cables of the fifteen 3-ton electric cranes to plug-in boxes on the electric mains fixed on the shed sides.

* Paper read before the Institution of Civil Engineers, November 29th, 1938. Reproduced from the Institution Journal by kind permission of the Council.

Improvements at the Royal Docks, Port of London Authority—continued

Two railway tracks with crossovers at the shed openings were provided, also five 2-ton electric capstans and fairleads.

In this and in other reinforced concrete false-quays described later, thick deck-slabs have been adopted to obviate waybeams, so that all crane and railway tracks and crossovers may be laid in any position desired on the quay, and also to take the wheel-loads of the heaviest road vehicles.

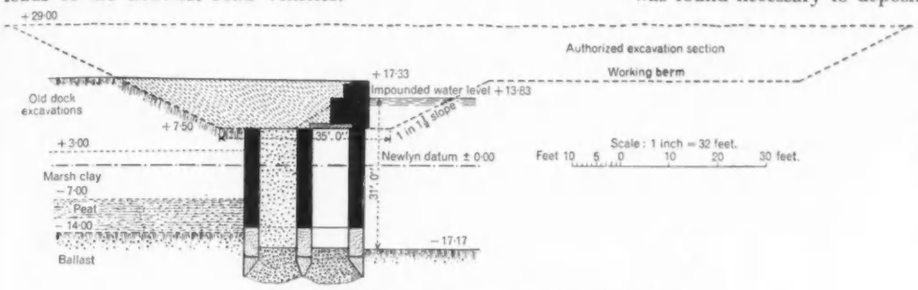


Fig. 12. Mudfield Site: Section through Main Quay

The sill and aprons of the Tidal Basin passage were broken up by a 10-ton ram rock-breaker and removed by bucket dredger, which also deepened the berths and south side of the dock to 31-ft. below impounded-water level.

The foundations of the new shed generally consisted of groups of four 16-in. sq. piles up to 35-ft. long driven to a set in the ballast, which averaged −10.00 N.D.; the pile-caps were 5-ft. sq. and 3-ft. deep, tied together transversely at 24-ft. centres, and longitudinally at the sides and centre by 12-in. by 21-in. tie-beams all formed of 1:2:4 concrete. The shed is 504-ft. long by 120-ft. wide, built of reinforced concrete framework and brick panels, and its three floors, each with a clear height of 12-ft., are completely divided into three sections by fire-walls. The upper floors are 6½-in. thick, and are designed to carry 3-cwt. per sq. ft. The roof is 6-in. thick, covered by three-ply "Ruberoid" sheeting with 2-in. of crushed gravel laid evenly over the surface; it is pierced by twenty-four 18-ft. by 7-ft. clear openings for lantern lights fitted with louvre-type ventilators and glazed with ¼-in. non-actinic glass to reduce heat-transmission. A 2-ton electric lift is provided at each division wall with two fire doors to each floor. Three 1-ton electric luffing cranes with a radius of 20-ft. are provided on the road side and one at each gable. The 8-ft. wide platform on the road side is roofed over, except at the crane bays, and the railways are paved for vehicular traffic.

These works were carried out by Messrs. J. Mowlem & Co., Ltd., and were completed in 85 weeks. The total cost was £270,000, the main items of which are: new quay, £70,000; shed and foundations, £91,000; plant and electric mains, £60,000; and £31,000 for the removal of "M" jetty (Fig. 1) and deepening the berths to 31-ft. below impounded-water level.

The Mudfield Site

This area of 27 acres at the south-east corner of the Royal Victoria Dock has remained undeveloped, due to the dumping thereon—possibly when the Pontoon Dock was formed—of a large quantity of excavation which covers about two-thirds of the area to a height of 15-ft. above impounded-water level.

The first stage in the development of this site was commenced in August, 1936, when the tender of Messrs. Sir Robert McAlpine & Sons, Ltd., was accepted for the construction of a main quay, about 1,200-ft. in length, on the same alignment as the existing south side quays, and of a return quay, 500-ft. long, towards the Pontoon Dock, with railway connections and new road approaches.

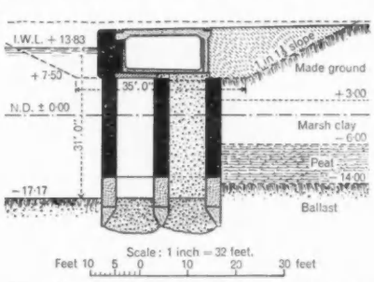


Fig. 13. Mudfield Site: Section through West Quay

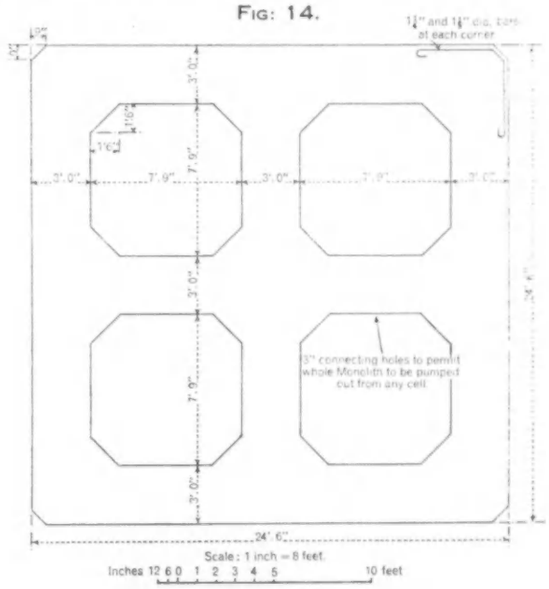
The main quay consists of a mass-concrete quay-wall (Fig. 12) founded on 42 concrete monoliths, and the west quay of a modified wall and reinforced-concrete tunnel (Fig. 13) founded on 18 concrete monoliths.

The excavation to the specified monolith sinking level of +7.50 N.D., or 6.50-ft. below dock level, was taken out to "authorised sections" (see Fig. 12) by diesel drag-line excavators, and after allowing for filling behind the quays the surplus was deposited on the dock side of the construction tracks, to be ultimately removed by the dredgers. Attempts to fill in the dock water area at the north-west corner with this material and to form a bank from which to sink six monoliths were unsuccessful as the material turned into slurry when tipped, and it was found necessary to deposit about 40,000 cu. yds. of dredged ballast before a stable bank was obtained. Most of the ballast was afterwards re-dredged and used to form land on the north side of the Victoria Dock.

The monoliths were 24-ft. 6-in. sq., with four 7-ft. 9-in. wells, and were 30-ft. 6-in. deep, when sunk, below the sinking level. The shoes were cast to a height of 10-ft., the upper 6-ft. of 6:1 ballast concrete and the lower 4-ft. of 1:2:4 concrete, reinforced with eight 1¼-in. diameter bars in each side and seven 1⅛-in diameter bars in each cross-wall.

The cutting edges were 6-in. wide with a taper of 2-ft. 6-in in a height of 3-ft. 6-in. (Figs. 14, 15 and 16). After sinking 9-ft. of grabbing and loading, strong pitch-pine shutters were erected, strutted and bolted together for the second cast of about 10-ft., which was sunk 9-ft. as before; the third cast followed, and the sinking stopped at 23-ft. below N.D. The amount of kentledge required for loading varied considerably, being up to 800 tons through peat and 540 tons through ballast. For this purpose 4 and 5-ton blocks of cast iron were used.

FIG: 14.


1¼" and 1⅛" dia. bars at each corner
3'·0"
1'·6"
7'·9"
3" connecting holes to permit whole Monolith to be pumped out from any cell.
24'·6"
Scale: 1 inch = 8 feet.
Inches 12 6 0 1 2 3 4 5 10 feet

MONOLITH DETAILS: PLAN OF SHOE.

The monoliths were pitched 12-in. behind the cope-line and 4-ft. 4-ins. apart; the worst final position was 7-in. forward and 18-in. sideways of the pitched position. The only troubles experienced in sinking were at the north-west corner where the monoliths were sunk from 16-ft. above N.D., through the tipped ballast bank, and struck the hardwood frames of an old ship which probably had been scuttled, and also not far off this, where a large wood-framed pickling tank was encountered full of a matted mass of creosoted wood rubbish. After pumping the wells, the hardwood was blasted and drawn, and the creosoted rubbish dislodged by a horizontal water jet from a 6-in. vertical electrical pump lowered down to undercut it. Fig. 17 shows the rate of casting and sinking of the monoliths of each quay.

After standing loaded for 24 hours, the four wells of each monolith were cleaned by divers and sealed with 5:1 concrete deposited from self-discharging skips to a height of 6-ft. above the cutting edge. The back wells were then filled to within 6-in. of the surface with 12:1 hearting concrete. All four wells of the main corner monolith were hearted. The spaces between the monoliths were sealed at the back by driving into the ballast four 15-in. octagonal concrete piles, arranged in arch form, the heads of these 30-ft. long piles were stripped, and the bars bent over into the concrete slab over the spaces. The front wells were covered with 12-in. pre-cast reinforced concrete slabs.

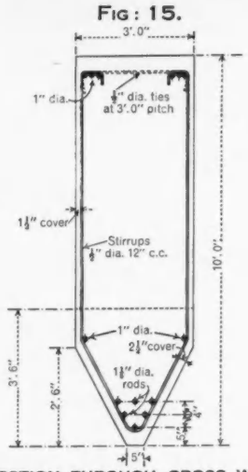
At the south-west corner, the quay wall of the Pontoon Dock (the foundations of which were only 15-ft. below dock level) was enclosed within a steel-piled box dam, cut down for a length

Improvements at the Royal Docks, Port of London Authority—continued

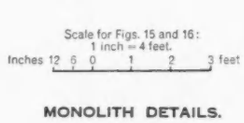
of 30-ft. and rebuilt in concrete from the same foundation level as the monoliths. The space between the new wall and the last monolith was closed with octagonal piles and covered as described above.

A grain-conveyor tunnel, 15-ft. 6-in. wide with an average height of 7-ft., was formed in the topping wall of the west quay (Fig. 18). For this purpose, the tops of the monoliths were made up to a uniform level in 6:1 concrete and finished to a reasonably smooth surface for waterproofing. After the construction of the quay wall and 12-in. thick reinforced-concrete back wall, a 6-in. strip of "Ruberoid" was laid along the bottom angles in three layers. The walls were treated in the same way, and all side and end joints were staggered. Immediately after laying the waterproofing courses a supporting lining of 1:2:4 concrete was placed on the floor and walls, and this was followed by the casting of the 16-in. thick reinforced-concrete roof pierced at about 18-ft. intervals with frames and covers for grain spouts. Asbestos-cement vent pipes, 4-in. in diameter, were placed under the coping between the tunnel and dock faces. An elevator track, consisting of two pairs of 75-lb. per yd. flat-bottom rails with centre flange-way at 18-ft. centres, was laid along the quay, and the quay surface graded at 1 in 60 to the dock.

FIG: 15.

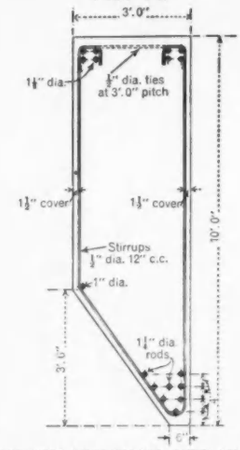


SECTION THROUGH CROSS WALL.



MONOLITH DETAILS.

FIG: 16.



SECTION THROUGH SIDE WALL.

The topping wall of the main quay, also constructed to a cope level of +17.33 N.D., was cast in 60-ft. lengths in two lifts, the front shuttering being in 24-ft. lengths with a full depth of 10-ft. In addition to tarring the keys of the vertical construction joints, two 1-in. expansion joints of bitumastic sheeting were provided in the total length. Cope bollards are provided at 85-ft. centres, anchored by tie-rods in counterforts into the back well of the monoliths.

During the construction, six 15-ton steam travelling derricks with a jib radius of 80-ft. were in use, grabbing, moving kentledge, shutters, and concreting. The materials for concrete were delivered by water to bunkers, and two 1 cu. yd. electrically-driven mixers erected on the north foreshore, and the concrete was conveyed to the derricks in skips on bogies hauled by 3-ft. gauge locomotives.

Prior to the construction of a new road approach from the highway to this area of the dock an access road, 20-ft. wide, of tar-macadam on hardcore was formed from Mill Road gate round the south side of the Pontoon Dock to the site. Railway sidings and a junction with the Silvertown line have been provided, and by an exchange of land with the West Ham Corporation, and the construction of a retaining wall, a railway connection to the dock lines westward was made across a former portion of the recreation ground.

These works were completed in 55 weeks at an inclusive cost of £175,000. The quays cost £124,000, which is at the rate of £70 per ft. run.

A quantity of the material in front of the main quay is required for the new work on the north side of the Victoria Dock, and is being removed under the dredging contract for that work. When the dredging at this site is completed to 31-ft. below impounded-water level, the deep-water width of the "canal cutting" will have been increased from 250-ft. to 600-ft. The width of the entrance to the Pontoon Dock was increased from 125-ft. to 340-ft. to allow a passage for craft between vessels moored at the quays, each with floating grain elevators delivering overside into craft.

Remodelling North Side of Victoria Dock

Having completed the deepening of the Connaught Road passage and provided some alternative berths and shed accommodation on the south side, the Port Authority decided to proceed at once with the remodelling of the north side of the Royal Victoria Dock, where nearly one-half of the total quayage was non-effective and only about one-tenth of the effective portion was modern in character, and it was possible to obtain accommodation for vessels up to 29-ft. draught at modern quays without the initial heavy cost of a new entrance.

Between berths "A" and "Z" at the east and west ends reconstructed and equipped for the discharge of meat, the existing accommodation consisted of five solid jetties constructed with horizontal arch panels of 14-in. brickwork between cast-iron columns built up from the dock bottom at 7-ft. centres and held in place by two tiers of 2½-in. diameter tie-rods, upon which the stability of the quay walls depended. These tie-rods were inaccessible for inspection and their condition not known until revealed by a collapse or bulging. There were also three intermediate shorter timber jetties generally used by discharged vessels. All these jetties were inadequate to deal at one time with the cargoes of vessels lying on each side, and thus only one-half of the quayage was effective; moreover, the structures were too frail to accommodate modern cranes, and too short for the vessels requiring to use them. These facts are not surprising when it is realised that the jetties were built 80 years ago, and that the whole dock is reputed to have cost only £730,000. It was the first dock in the port to have railway facilities, and also the first to be equipped with hydraulic power for operating the machinery.

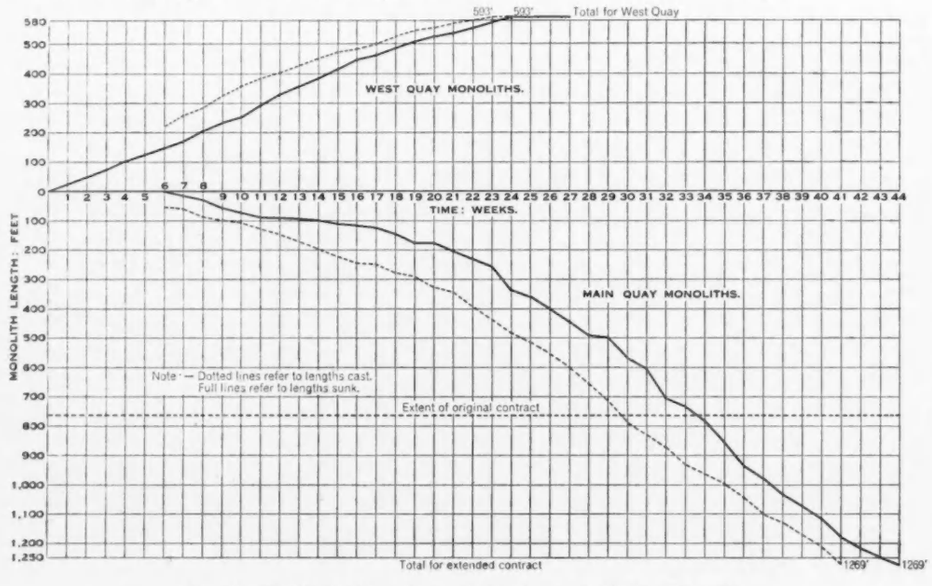


Fig. 17. Mudfield Site: Rates of Casting and Sinking Monoliths

The scheme adopted consists of a continuous open-type reinforced-concrete quay, about 3,250-ft. long, sited to provide width for a 150-ft. shed, railways, and road, all clear of "X" warehouse at the west end and lining up with "A" berth at the east end, where the minimum width of the water area is 600-ft. This involved the removal of the southern end of the jetties and the reclamation of the water area on which five modern three-storey warehouses, each 504-ft. by 150-ft., are to be erected and provided with road and rail facilities; the rail access to the two tracks on the new quay being effected by an opening 240-ft. wide between the sheds near the centre of the quay. The estimated cost of this work, including crane equipment, is £1,200,000.

Contracts amounting to £341,500 have been entered

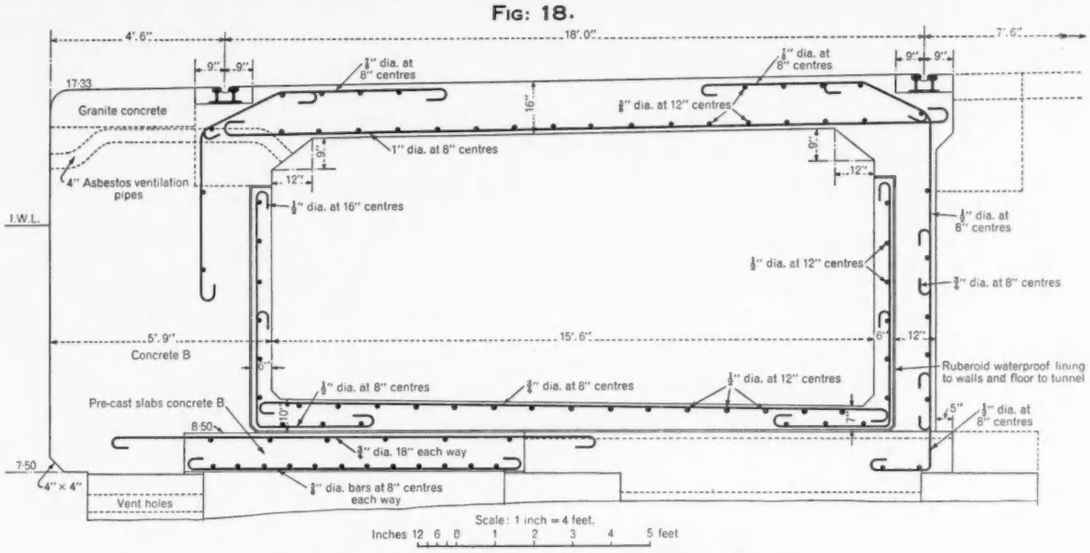
Improvements at the Royal Docks, Port of London Authority—continued

View of North Side, Victoria Dock, showing old A and B Jetties. Note projecting ends of ships

Steel reinforcement in Transverse Beams, North Quay, Royal Victoria Dock

Improvements at the Royal Docks, Port of London Authority—continued

FIG: 18.



WEST QUAY: SECTION THROUGH CONVEYOR TUNNEL.

into with Messrs. J. Mowlem & Co., Ltd., for the construction of the quay in 26 months, and with the Tilbury Contracting & Dredging Co., Ltd., for the removal of the jetties, deepening and land reclamation where required. Work was commenced at each end of the site in January, 1937.

At the west end cylinders were sunk and the small recess decked over for the extension of "Z" shed and quay 120-ft. eastward to "I" jetty, where pre-cast sheeting piles were driven along the west side of the jetty prior to forming a false quay on one row of cylinders. At the same time, the demolition of "I" jetty by blasting, cutting tie-rods, and dredging was proceeding, the dredged material being deposited from small hoppers in the shore ends of the bays after the removal of the small timber jetties and the accumulated mounds of mud underneath them. These timber jetties each contained from 300 to 400 piles from 40 to 45-ft. long, which were extracted by a wreck lighter at an average rate of 13 per day, the highest number per day being 24.

The masonry of the gate recess and remainder of the sill at the south end of "I" jetty were broken up by a 15-ton rock-breaker and removed by dredger.

The procedure followed for the construction of the new quay (Fig. 19), consisting of three rows of cylinders with strong transverse beams supporting 14-in. thick concrete sheet-piling for retaining the filling of the areas to be reclaimed, was as follows:

The mud was removed from the dock bottom, and ballast from the deepening of the dock was deposited from small hoppers up to a level of −1.0 N.D., thus leaving 15-ft. of water over a top width of 200-ft. required for the quay and shed. A temporary staging of five rows of timber piles, 45-ft. long at 24-ft. centres, was then erected, for supporting the steel guide-cages and to carry the sheet-pile frame and a 5-ton steam crane near the back row of cylinders. A 7-ton floating crane was used for sinking and hearting the front cylinders (Fig. 20), pitching piles, and placing the pre-cast soffit beams in position. A floating mixer plant was used for the hearting, cope and back beams, and a concrete pump for the rest of the beams and deck-slabs.

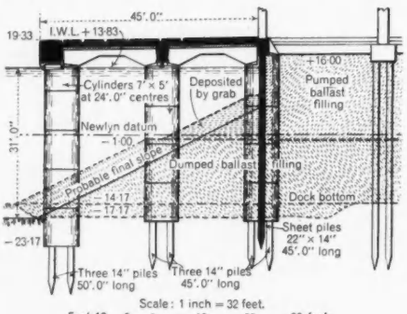


Fig. 19. Victoria Dock: Section through North Quay

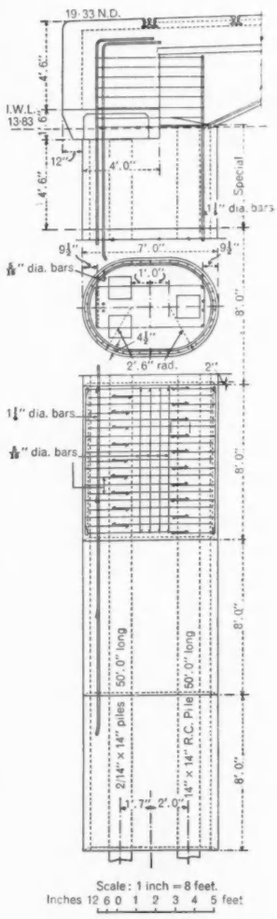
The ballast bank was stopped about 200-ft. short of the next jetty to be demolished, that being the length required for the dredger to work through. The removal of each jetty end took about five months, as about a month was required for each of the following operations:—

(a) Demolition of the southern half of brick shed.
(b) Demolition of arches to vault floor level.
(c) Drilling and blasting shed foundations.
(d) Drilling and blasting quay walls.
(e) Dredging and removal of jetty end.

The jetties were removed to 68-ft. behind the new cope-line, and before depositing the ballast bank the dredger made a searching cut to −17.0 N.D. over the site of the cylinders, which was also raked over by three grapnels attached to a heavy drag towed by a small tug.

On completion of the new quay between two of the solid jetties the water area was reclaimed to +16.0 N.D. (that is, to the level of the underside of the shed foundations), by pumping ballast through a 24-in. pipe-line from pumping plant moored alongside the new quay, the ballast being obtained from the deepening of the dock and conveyed in special barges. Northward of the new shed sites, demolition materials were deposited up to existing quay-level as reserve filling.

FIG: 20.



CYLINDER DETAILS (VICTORIA DOCK, NORTH SIDE).

Progress at the west end was delayed about six weeks owing to the percolation of dock water from the vaults of "G" jetty, which are about 7-ft. below impounded-water level, into the lower basements of a large warehouse on the north side of the roadway. It was found that the water was travelling through the lime-mortar joints of the brickwork foundations of the vaults, and thence along the outside skin of a tunnel connecting them to the warehouse basement. The trouble was not cured until interlocking steel sheet-piling had been driven across the tunnel and half the width of the jetty.

It should be mentioned that the roof-water of the jetty warehouses was run into the vaults, and they were drained through brick barrels laid at marsh-level into the marsh-ditch along the dock boundary; before any jetty was flooded, a trench was cut across the north end of the vaults and all outlets plugged and sealed under a head of concrete.

Expansion joints, 1½-in. wide, were formed about 336-ft. apart along the quay by 12-in. wide trimmer beams on steel bearing plates. It may be of interest to record the centres at which the following quay equipment was provided:

Cope bollards	... ...	96 feet
Life ladders	... ...	192 „
Barge-mooring rings	...	48 „
Fresh-water hydrants	...	96 „
Access manholes	...	192 „

The standard radius for railway lines to the road side of the

Improvements at the Royal Docks, Port of London Authority—continued

sheds is seven chains, but for access to the quay lines the radius is slightly less than four chains.

General

The deepening of the north quay and channel of the Royal Albert Dock to 34-ft. below impounded-water level was completed in 1936, and when the deepening of the Royal Victoria Dock to 31-ft. below impounded-water level is accomplished, the total increases over the original depths in these docks will be 7-ft. and 5½-ft. respectively.

Since the completion of the deep-water river-channel in the spring of 1921, a depth of 30-ft. below low-water spring tides has been available from the Nore to Coldharbour Point, and 27-ft. below the same datum up to the Albert Dock.

For many years the period of locking for shipping was 3½ hours before, to half-hour after, high water, but in 1926 this was increased to five hours before to three hours after. This 8-hour locking is still worked at the King George V entrance, but in 1932 it was altered at the Albert Dock entrance to four hours each side of high water for shipping and craft.

The accompanying diagram (Fig. 21) shows the period of time the depth of water in the three docks is available over the sills of the King George V entrance, and indicates that the shipowners' ideal conditions of locking at any state of the tide, even for a 31-ft. dock, would require a lock and river depth of not less than 31-ft. at low-water spring tides.

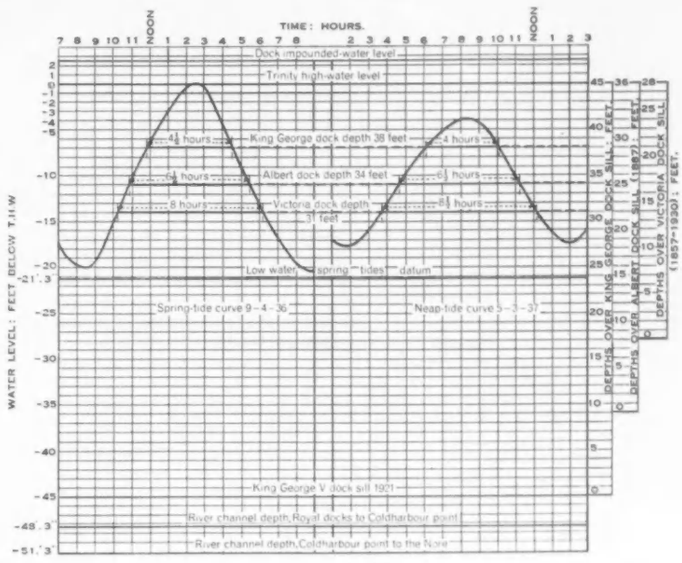

TIME: HOURS.
NOON
Dock impounded-water level
Trinity high-water level
WATER LEVEL: FEET BELOW T.H.W.
4½ hours
King George dock depth 38 feet
4 hours
6 hours
Albert dock depth 34 feet
6½ hours
8 hours
Victoria dock depth 31 feet
8½ hours
Low water spring tides datum
Spring-tide curve 9-4-36
Neap-tide curve 5-3-37
King George V dock sill 1921
River channel depth Royal docks to Coldharbour point
River channel depth Coldharbour point to the Nore
DEPTHS OVER KING GEORGE DOCK SILL: FEET.
DEPTHS OVER ALBERT DOCK SILL (1897): FEET.
DEPTHS OVER VICTORIA DOCK SILL (1937-1939): FEET.

Fig. 21. Depth of Water Available over the Sills of King George V Dock Entrance

For convenience, the relationship of the data referred to is as follows for the Royal Docks:

Newlyn datum (N.D.) is 1.17-ft. above Ordnance datum.
Trinity High Water is 12.5-ft. above Ordnance datum.
Impounded-water level is 15.0-ft. above Ordnance datum.
Low-water spring tides (L.W.S.T.) is 8.75-ft. below Ordnance datum.

Acknowledgments

The recent improvements in the Royal Docks described in this Paper, authorised by the Port of London Authority under the Chairmanship of Lord Ritchie of Dundee, were carried out to the design and under the direction of Mr. Asa Binns, M. Inst. C.E., Chief Engineer, and Mr. F. W. D. Davis, M.Sc., M. Inst. C.E., Chief Assistant Engineer. The Author has supervised the works at the Royal Docks since 1930, assisted at various times by Messrs. A. F. Grant, B.Sc. (Eng.) and John Anderson, Assoc. MM. Inst. C.E., Mr. S. T. Smith, Mr. A. L. Wheeler, B.Sc. (Eng.), Stud. Inst. C.E., and Messrs. W. T. Oliver and W. H. Ashmore, senior Clerks of Works.

The Author would like to take the opportunity of mentioning the happy association with his colleague Mr. R. E. Knight, M.C., M. Inst. C.E., the mechanical Assistant Engineer at the Royal Docks, and with Mr. D. G. Davies, who supervised the mechanical and electrical equipment respectively of the new works described.

The whole of the contract drawings were prepared in the Port Authority's drawing office under the supervision of the Chief Draughtsman, Mr. W. B. Hall, M. Inst. C.E.

The contracts were based on firm schedules of prices, both for labour and materials, and Messrs. George Corderoy & Co. acted throughout as the Quantity Surveyors.

The main Contractors were represented on the sites by Mr. J. Hardie and Mr. E. Downes, M.C., B.Sc. (Eng.), Assoc. M. Inst. C.E., for Sir Robert McAlpine & Sons, Ltd.; Mr. R. Swager, Assoc. Inst. C.E., and Messrs. J. A. Ross, Assoc. M. Inst. C.E., and B. S. Holmes for Messrs. J. Mowlem & Co., Ltd.; and Mr. J. H. W. Turner, B.Sc., Assoc. M. Inst. C.E., for Messrs. C. Brand & Son, Ltd.

Liverpool Tidal Institute

In the Annual Report for 1938 of the Liverpool Tidal Institute, the following observations are made in regard to research work, carried on under the Director, Professor J. Proudman, F.R.S., and the Assistant Director, Dr. A. T. Doodson, F.R.S.

The intensive study of the structure of a tidal current has been continued.

Much work, especially by Mr. Corkan, was done on the calibration of the Favé gauges. Many difficulties were experienced in the attempt to obtain calibration tables which were reliable to a sufficient degree of accuracy for the purpose in hand. All the earlier attempts were made with a specially constructed mercury manometer, but the most trustworthy results were obtained by placing the gauge in an actual tide-well and then dealing only with harmonic constituents.

The records taken by the Favé gauges in the summer of 1937 were then analysed. The results give well-determined differences between the M_2 constituents of the tidal elevation at the three stations. These results have yet to be combined with the determinations of the mean currents made from the observations of 1936, so as to give forces of friction.

The work at sea in 1938 was carried out during five weeks in July and August. This work was restricted to the operation of the new current-meter at one station to the south of the Isle of Man. Many records were taken from different depths, at different phases of the tide, and for a variety of states of the sea surface. These were of the following types:—

1. Continuous records of the instantaneous speed of the current.
2. Intermittent records of the instantaneous values of the speed and direction of the current every 30 (or 15) seconds.

From these records it is hoped to determine:—

1. The smaller frequencies of the turbulent variations in the speed of the current.
2. The magnitudes of the mean values (e.g., over 15-minute intervals) of the energy of the component of turbulence in the direction of the mean current.
3. The classification of such characteristics of turbulence according to depth, mean speed of current, phase of tidal current, phase of fortnightly inequality of tidal current, wind and state of the sea surface.

The work at sea was again made possible by a grant to Professor Proudman from the Government Grant Committee of the Royal Society. It was again carried out in collaboration with the University Department of Oceanography, using the Department's motor boat "Zephyr."

The paper by Dr. Doodson contains a further instalment of the researches dealing with tides in oceans bounded by meridians. The first three parts were concerned with an ocean bounded by a complete meridian and thus covering half the earth. The fourth part deals with narrow oceans and a series-solution in terms of the width of the ocean is given. The fifth part of these memoirs is also nearly completed, and concerns the tides in broader oceans.

The paper by Mr. Corkan, on the tilt of the ground at Bidston, gives the results of his analysis of a year's record by the Milne-Shaw instrument, which was described in the Report for 1934. The semi-diurnal constituents of the tidal tilt have been satisfactorily determined and their origin discussed, but the diurnal constituents are somewhat uncertain.

A commission has been accepted from the London County Council for a study of storm surges in British waters, with particular reference to those surges which cause floods in the Thames area and on the East Coast.

The tidal observations taken by the British Graham Land Expedition of 1934-37, have been reduced by Mr. Corkan, and he has prepared a report on the work, in which he also compares the results with those obtained by previous expeditions.

The collection of monthly and yearly mean heights of observed sea level, for the International Association of Physical Oceanography, has been continued.

*Methods of Coal Loading for Export Trade**

By R. F. HINDMARSH, M. Inst. C.E., Chief Engineer of the Tyne Improvement Commission

THE Author wishes first to thank the Société des Ingénieurs Civils de France for the honour accorded him in being asked to address so distinguished a body of Engineers.

The methods of handling coal for export differ so widely in different countries and at various ports that in the limited time at his disposal the Author can only, firstly, give some general observations; secondly, briefly mention many of the interesting methods adopted, and, thirdly, give rather fuller details of the plants on the River Tyne which have been recently installed to his design or under his supervision with brief references to special provisions which have had to be made or difficulties overcome.

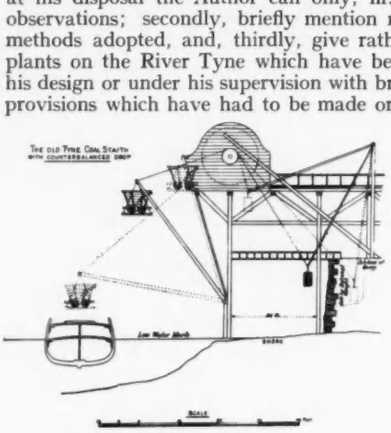


Fig. 1 Balanced Drop

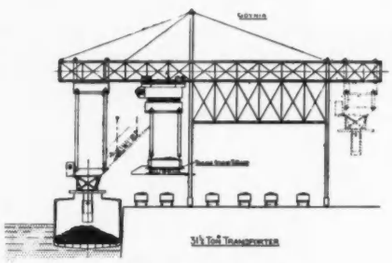


Fig. 2. Transporter

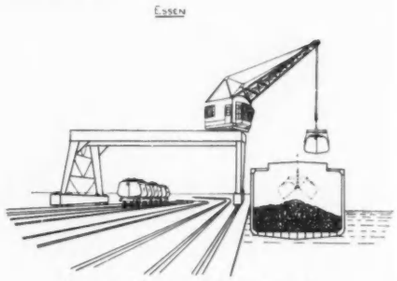


Fig. 3. Crane lifting Container

General Observations

The shipment of coal in British ports is of considerable antiquity. Coal from Tyneside was taken by sea to the Thames more than seven centuries ago, and there is a record of shipment of coal from the Tyne to France in the year 1325. Until the 18th century, however, it was insignificant in amount.

In 1791, the total shipments from British ports amounted to 335,000 tons; in 1850 it had risen to 11 million tons; while last year (1937) it was 54½ million tons.

In early days before the advent of railways, coal shipment was carried on by means of appliances of the simplest character —low staiths or timber jetties fitted with "spouts" through which the coal was discharged into barges or the holds of small sailing ships—even baskets were used, such as are used in the East to-day.

"Balanced drops" were used early in the 19th century. Chaldron wagons, containing about four tons, were run on to a cradle hung from hinged lever arms, and both cradle and wagon were lowered over the ship's hatchway. After the coal had been emptied through the bottom doors of the wagon, the cradle was raised by balance weights and the wagon run off. In some cases the cradle was lowered by ropes from an overhanging frame. Improved appliances of this type were in use at some of the older docks in South Wales until recently (Fig. 1).

In another early appliance, the coal was brought from the colliery in containers or box skips which were lifted off their wheeled undercarriage and lowered by crane into the ship's hold. As a means of reducing breakage of coal to a minimum, this is almost ideal. I shall refer later to its development in Germany.

Wagons

The coal wagons used for shipment at the north-east coal ports of England are principally of the bottom-door type. "Chaldron" wagons, which have doors of this type, are still in use at several private colliery staiths on the Tyne and Wear. They are unsuitable for haulage over railway company's lines. Wagons with end doors have to be tilted to discharge the coal and hoists or other appliances for dealing with these wagons are provided with tilting cradles, usually worked by hydraulic power.

Coal is also sometimes discharged from wagons by means of a tippler which can turn the wagon over sideways—some only oscillate, others turn through a complete circle.

The British coalfields are situated near the sea coast, and this to some extent, determines the type of appliance used for the loading of ships. 10-ton wagons are still used in many ports, while 20-ton wagons are largely used on the North-East Coast. The use of high-capacity wagons materially reduces the cost of transport and increases the capacity of the standage sidings. In America, where the coal is rail-borne for long distances before reaching the port, 50 to 100-ton rail cars are used, and these entail the use of powerful appliances and machines for handling such wagons.

Standage

A good railway lay-out is essential for expeditiously conveying loaded wagons to the shipping appliances. The standage railways, which are necessary in order to give quick despatch to ships, should be as straight as possible and be at a slight gradient to allow the wagons to creep forward by gravity. In England,

* Paper read before the British Section of the Société des Ingénieurs Civils de France, on 13th June, 1938, and reproduced by permission.

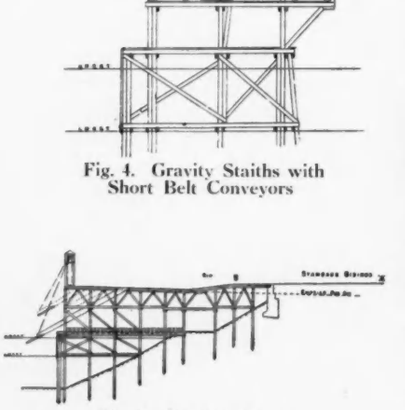


Fig. 4. Gravity Staiths with Short Belt Conveyors

Fig. 5. Gravity Spouts

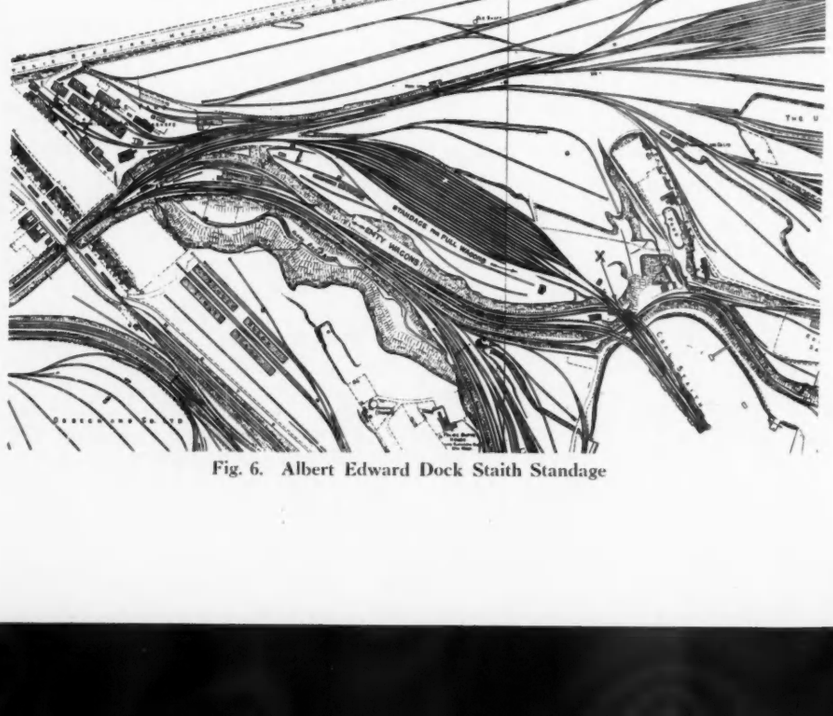


Fig. 6. Albert Edward Dock Staith Standage

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1 in 90 or 1 in 100 has been found suitable for wagons in good condition. After discharge the empty wagons run back down a steeper gradient of perhaps 1 in 80 or 1 in 75, as far as the level of the ground will allow before being hauled away again to the pits. The largest storage sidings in Europe are at Immingham Docks, on the Humber, and hold nearly 200,000 tons of coal; the empty sidings hold 5,500 wagons.

Fig. 6 (Albert Edward Dock Staith on the Tyne) is a good example of a nearly straight standage ground with the run-back lines. It will be noticed that one of the run-back lines passes under the full road at X to join its fellow-line from the other side.

Fig 9 (Jarrow Staith on the Tyne) shows a curved standage ground, which has, of course, to be laid at the steeper gradient of 1 in 70 to permit wagons to creep round the curve. The empty wagons in this case are raised by automatic electric hoists and run back above the full lines on steel trestles and later on an embankment until they arrive at the original level of the near the end of the staith, which is at a slightly lower level than the top of the "kip." They are stopped over one of the hoppers, constructed under the deck of the staith, and the bottom doors of the wagons are dropped to allow the coal to fall into the hopper and down one of the shoots, which are constructed at an angle of 1.8 horizontal to 1 vertical. It will be seen from the diagram that there are several tiers of these shoots each with a hopper at the top, one or other is used as desired. On reaching the bottom of the shoot the coal slides on to a movable spout, which can be set to coincide with whichever shoot is being used. This spout may be 25 or 30-ft. long with a telescopic extension piece to reach still further out over the vessel. This is usually set at a flatter angle than the fixed shoot (about 1 in 2), and has a trap-door or flap at the end to regulate the flow of coal. It is generally kept closed until the whole spout is full, when it is opened to allow the coal to slide out much more slowly than if it were allowed to slide the whole way down the empty spout—this avoids breakage.

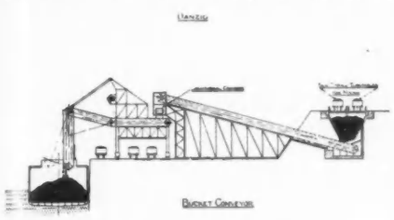

Fig. 7. Bucket Conveyor

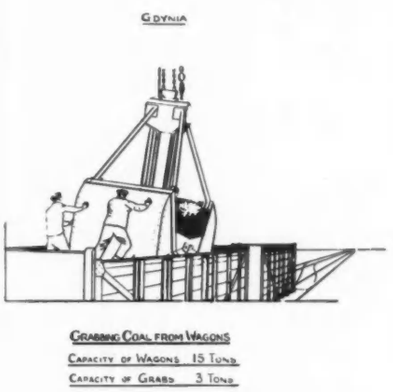

Fig. 8. Grabbing Cranes

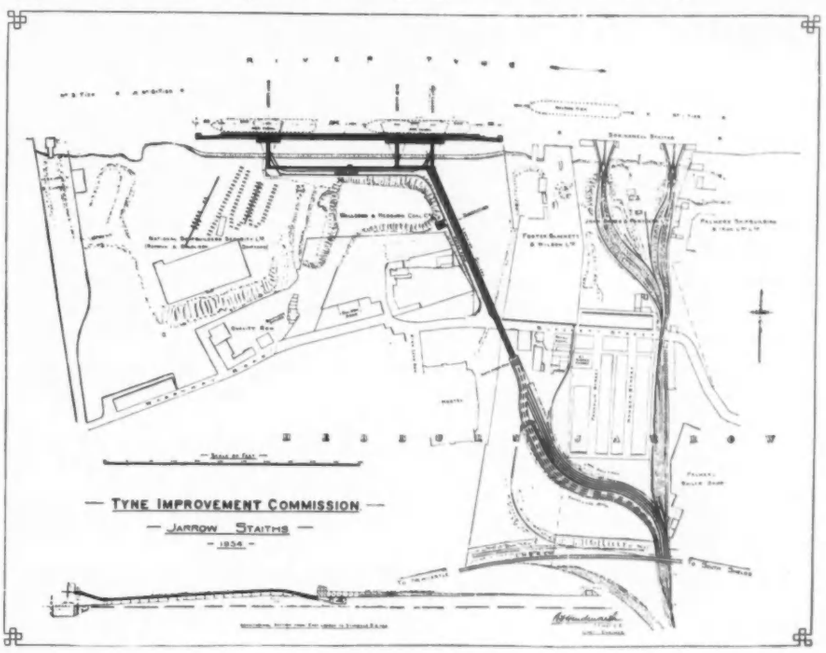

Fig. 9. Jarrow Staith Standage

standage ground. In some cases this method of dealing with the empty wagons effects very considerable economy in the ground area required for the run-back, although adding to the machinery to be maintained. The curve in this case was unavoidable and necessitated by the shape of the ground and direction of the existing railway lines.

The levels of the ground often determine the type of shipping plant employed. A river such as the Tyne, which has high banks on each side, is particularly suitable for gravity working. The nearer to the shipping point the coal can be brought in wagons the cheaper will be its transfer to the ship. With low-lying land for some distance behind the quay it becomes a matter for estimating whether a railway on elevated trestles to carry the wagons will not be more expensive than discharging the wagons at some point further back and transporting the coal on a belt or other form of conveyor.

The following are some of the principal means of loading coal into vessels:

(1) Gravity spouts, where wagons gravitate down to the point of shipment and the coal is dropped into hoppers and runs down a spout into the vessel.
(2) Gravity staiths where wagons gravitate down to the point of shipment and the coal is dropped on to a short belt conveyor reaching over the vessel, thus giving greater height and outreach for shipment.
(3) Hoists of various kinds—hydraulic and electric.
(4) Bucket conveyors.
(5) Transporters.
(6) Floating elevator transporters.
(7) Grabbing cranes.
(8) Cranes which lift wagons or containers and empty them into holds of ships.
(9) Long belt conveyors.

A quantity of coal is still shipped from what are called "staiths" in the northern districts of England, and a typical example of such a structure is shown in Fig. 5. This shows a short steep gradient called the "kip" or "tip" down which wagons are run one at a time and then up a rising gradient to

Considerable height is taken up between the bottom of the hopper to the end of the spout, and if a vessel is high out of the water, it may be impossible to use the shoots and spout at high tide. In such cases, short horizontal band conveyors may be placed under the hoppers and run out over the vessel and the belt adjusted to the required height and angle.

Fig. 4 shows one of these short conveyors. At present 12 of them are in use at the Tyne Improvement Commissioners' Docks and Staiths.

These conveyors are mounted on a carriage and can be run out over the vessel, elevated, depressed and slewed. The belt is a flat one, 34-in. wide, not troughed, and has sufficiently high side skirting boards to enable it to carry a thick stream of coal or coke. It is driven by a 20-h.p. motor, and can handle 800 tons of coal per hour. An anti-breaker can be used with these if necessary.

If a still higher point of discharge be needed a hoist is used. The lifting cradle has a hopper on the underside, and is carried up to the required height before the coal is discharged into it. The illustration shows a hydraulic hoist which lifts the wagon from quay level and gives uninterrupted use of the quay railways when the hoist is not being used. The hoist may be fixed as shown or movable. For wagons fitted with end doors the cradle and wagon is tilted and the coal discharged into a hopper placed in front of it forming the upper part of the gravity spout.

Hydraulic power has been mostly employed for coal hoists in Great Britain, but electric power is now frequently used. The Tyne Improvement Commissioners have four hydraulic hoists—three worked by direct-acting rams under the cradle, and in the one shown in Fig. 22 the cradle is lifted by wire ropes passing over sheaves at the top and down to the hydraulic mechanism on the back of the tower.

Bucket conveyors, fixed, travelling and on floating craft, are used on the Continent and Baltic ports. The example shown in Fig. 7 is at Danzig. The conveyor is fed from railway sidings above quay level, where twin turntables are fitted so that the cargo can be mixed if required. The inclined chain of buckets conveys the coal from the hopper and discharges on to a longi-

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Fig. 10. Wallsend & Hebburn Coal Co.'s Crane and Box Skips

Fig. 11. Anti-Breaker

Fig. 12. Anti-Breaker

tudinal conveyor, which by a " throw off " discharges on to the conveyor, which revolves on the travelling structure. A portion of this conveyor is arranged to hinge and the leg is capable of moving athwartship. Only a limited degree of adjustment for height and breadth of vessel is capable on this appliance. It is mostly used for the smaller classes of coal, and no anti-breakage appliances are provided.

Another method of loading a vessel is by means of a transporter, shown in Fig. 2. It consists of a bridge travelling on two lines of rails with overhanging boom to give the necessary outreach over the quay. The main wagon-lifting crab has a lifting capacity of about 32 tons, and is provided with a slewing frame from which the wagon is suspended. A hopper is also suspended from the bridge, and when the ship is berthed the hopper is traversed and lowered into the hold of the vessel. The hopper while in use is supported by beams resting on the coamings of the hatchway. A telescopic power-operated shoot is fitted to the bottom of the hopper, which enables the lower portion to be raised and lowered to suit the height of coal in the hold. When operating, wagons which are of the " end door " type are drawn over a ramp on to the cradle by an electric winch fitted to the cradle, lifted to the required height, slewed to suit the end door and traversed to a point suitable for being tipped into the hopper on the hatchway. As originally designed, it was intended that the shoot below the hopper should be kept full, the telescopic portion resting on the heap of coal below and raised as required to let the coal out. This considerably reduced the height of free fall from the wagon. More often than not the shoot is allowed to empty itself, and the next wagon of coal falls straight through to the bottom of the hold with the inevitable breakage. The plant is rather cumbersome and slow and cannot, in the Author's opinion, compare favourably with a well-designed belt conveyor.

Warkworth Harbour Anti-Breaker Appliance

A suspended hopper with telescopic tube at the bottom can be made to act as an anti-breaker. Morrison-Leonard anti-breakers are used at Warkworth Harbour, in Northumberland. The lowest ring of the tube is provided with a skirt, to which a number of prongs are fixed, and some coal can escape between these. There are also four telescopic prongs which remain embedded on the heap when the fixed prongs are lifted. These steady the tube. The tube itself is lifted and telescoped by the crane, while a small shipping winch is used to lift the skirt, and this is under control of a man on the vessel who raises it little by little until the coal flows out from under the ends. By this means the hopper can be always nearly full, and the spout discharging into the hopper can also be kept well filled, so that there is no real drop for the coal to be subjected to after it leaves the wagon—once the telescopic tube is filled. This is particularly suitable for small vessels as a long tube is cumbersome to handle.

Floating Elevator Transporters

Floating appliances—some of very large capacity—are used for bunkering and cargo shipment. The elevator is often carried on a pontoon moored between the river barge and the sea-going ship. It is equipped with a bucket elevator conveyor and one or more telescopic shoots for transferring the coal from barge alongside the elevator transporter to the ship. Bunker coal is often loaded from a self-propelled coaling craft. The coal stored in the well of the vessel is discharged to a conveyor passing under the well, through doors fitted with slides, conveyed to the required height and discharged into a telescopic shoot to the ship's bunker hatches.

Grabbing cranes are chiefly used in the discharge of coal shipments rather than in loading, but where a suitable type of wagon is employed, grabs can be used for loading a vessel. Fig. 8 shows a grab picking up coal from a wagon. The grab is worked from a crane on an overhead gantry and each load is swung out over the vessel, lowered into the hold and discharged —it is a slow process, men being required to manipulate the grab in the wagon, and it is difficult to see how a wagon can be properly emptied by this means.

A much better use for the grabbing crane as a loading appliance is for bunkering purposes from river craft to ocean-going vessels. Floating cranes of 8 to 10 tons lifting capacity operating 5-ton grabs are used at Antwerp and elsewhere to lift the coal from barges to the vessel's bunker hatches.

On the Rhine-Herne Canal, coal is brought to the shipping quays in special steel containers, formed in halves very like a large grab. They are transported on flat trucks (Fig. 3). A crane lifts the containers, each holding about 11 tons of coal, from any one of the rail tracks, and loads the contents into barges with a minimum of breakage. The trucks carry four of these containers, and three tiers of barges can lie side by side alongside the quay and can be loaded by means of the cranes which can reach out over them all. This system is probably the most effective anti-breakage device yet devised. The cranes are mounted on a travelling gantry, usually referred to in England as a " transporter " and in America as a " coal bridge."

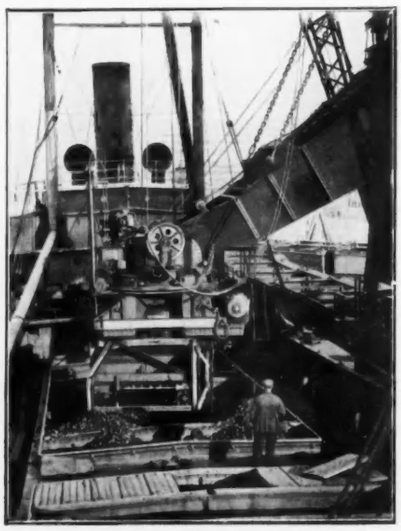

Fig. 13. Anti-Breaker

Fig. 14. Sheer Legs Support

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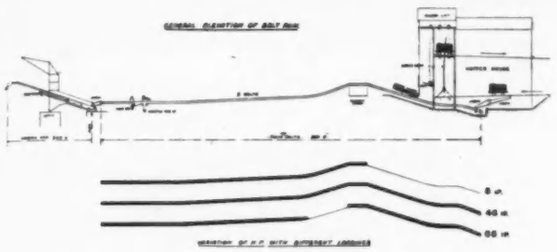

Fig. 15

Another use of cranes is to lift and tip a wagon directly into the ship's hold.

Goole Docks. Boat Hoists

There are four hydraulic hoists at Goole Docks for the shipment of coal, which is conveyed from waterside collieries by means of compartment boats.

Each compartment holds approximately 40 tons, and a train comprises a tug (with headpiece) and 19 compartment boats, thus 700 to 800 tons of coal can be conveyed to Goole for shipment by the employment of a single tug.

Fig. 21 shows the train of loaded boats.

The compartment boats are first floated over a submerged hoist cradle and then lifted out of the water by means of the hoists and the coal tipped into the sea-going vessels.

In order to minimise the breakage of coal on shipment, two of the hoists have been equipped with specially designed Mitchell anti-breakage appliances (see Fig. 13).

Fig. 14 shows the sheer legs for carrying the anti-breaker.

In the case of the last anti-breakage appliance to be installed, the ordinary hoist chute was taken down and a mild steel receiving hopper fixed, into which the coal is delivered from the compartments as they are discharged by the hoist.

This hopper is arranged to feed the coal on to a short inclined belt conveyor, which delivers the coal into the anti-breaker.

The belt conveyor has a width of 54-in., and operates at a comparatively slow speed, in order that the coal may be delivered in a steady stream without breakage.

The conveyor is of the telescopic type, arranged in such a manner that it can be extended a distance of 8-ft., thus giving a wide range for loading to ships' bunkers.

The anti-breaker comprises a circular mild steel telescopic chute to the bottom end of which a belt feeder is fitted for discharging the coal into the hold of the vessel being loaded. The anti-breaker is arranged so that it can continue to rotate in either direction, a complete circle of 360° without any limit to the number of revolutions.

The feeder conveyor is provided with racking and slewing motions, thus increasing the range of the anti-breaker. The telescopic chute can also be raised and lowered to suit the loading conditions.

The operation of the anti-breaker is such that the conveyor at the bottom of the telescopic tube is started and stopped by the action of coal in the tube.

The tube is filled with coal from the inclined supply conveyor, and upon the coal reaching a pre-determined level near the head pulley of the conveyor, the short feeder conveyor at the bottom of the tube is started up and extracts the coal from the tube. Immediately the level of the coal at the top of the tube falls, the motor at the bottom is stopped until the level of the coal again rises. By this means the level of the coal at the top of the tube is kept within narrow limits, and the fall of coal from the conveyor to the anti-breaker is reduced to an absolute minimum.

Electrically-operated winches are provided at the rear of the hoist for controlling the movements of the anti-breaker and luffing of the shear legs.

A further electrically-operated winch is provided at the top of the boat hoist structure, in order that the telescopic supply conveyor between the hopper and the anti-breaker can be conveniently raised and lowered.

Electric driving motors are provided for all motions of the anti-breaker, and the controls are located on the top operating platform of the boat hoist.

Fig. 20 shows the compartment boats being loaded while afloat; they can also be loaded at an inland colliery and run down to the canal on special carriages, the track being continued down a slipway into the water far enough for the boats to float off.

The Author is indebted to Sir John Eaglesome, Managing Director, Aire & Calder Navigation, for the description and illustrations of these most interesting appliances.

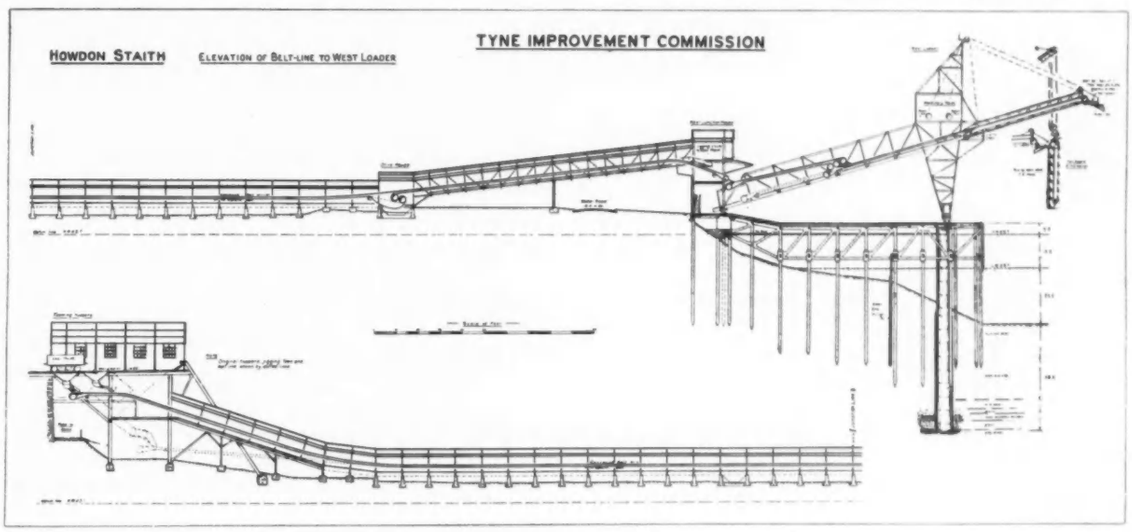

Fig. 16. Howdon Staith

American Methods

The Paper would not be complete without some reference to American methods. The author can only mention one outstanding example—the Curtis Bay coaling plant of the Baltimore and Ohio Railroad. It is installed on a double-sided reinforced concrete pier, 700-ft. long and 117-ft. wide, having a minimum depth of 35-ft. alongside. Freight cars up to 100 tons coal capacity are brought over railway tracks to two car-dumpers situated at some distance from the pier, where they are raised and tipped into high-level hoppers of 120 tons capacity. Each hopper feeds three 60-in. belts running at a maximum speed of 500-ft. per minute. Two of the belts from each dumper group run out along the pier direct to the loading towers, while the third in each group feeds a series of storage bins which are used for both equalising delivery of the direct running belts in case of a temporary interruption of delivery, and also for bunkering.

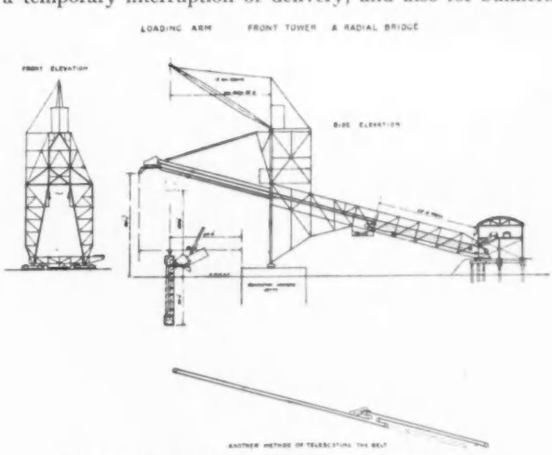

Fig. 17. Alternative method of Telescoping Belt

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Fig. 18. Cast Steel Rack

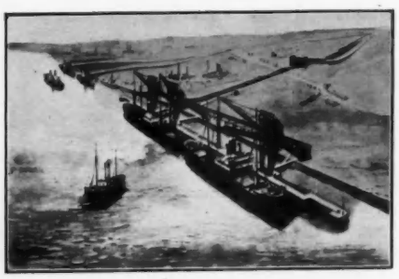


Fig. 19. Jarrow Staith. General View

Fig. 20. Compartment Boats

Each loading tower can travel longitudinally, and is provided with a delivery arm, which has a vertical range of 27-ft. and an outreach of 45-ft. from the side of the pier. Two traversing belt conveyors, receiving their coal from the storage bins, are used for bunkering. A record shipment of 3,684 tons of coal has been loaded into one vessel in an hour.

Here, as at many other American ports, a mechanical trimmer is used. This is a short high-speed horizontal belt on the bottom of a telescopic tube, which conveys the coal from the conveyor down into a vessel's hold. The trimmer revolves round the tube and can throw the coal in any direction towards the ship's sides. This appliance is not suitable for use with the large brittle coals shipped in the United Kingdom. One was made and tried at the Commissioners' Docks on the Tyne, but its use was not continued.

Fig. 16 shows the arrangement at the Tyne Commissioners' Howdon Staith, which was opened for use in 1932. After discharging the coal from the wagons into a hopper, the discharge is regulated through adjustable doors on to jigging feeders which pass a regular stream on to the two belt conveyors, which are at first near ground level but climb an incline of about 1 in 10 to the west junction house, where the west conveyor deposits its load on to the inclined belt of the west shipper through a connecting chute, the east conveyor delivers its load on to a curved steel jigger, and then to a belt in the elevated gallery along the embankment and again down a curved jigger on to the inclined belt of the east shipper—these latter inclined belts rising about 1 in 4½ up to the hinged portion of the loading arm where the angle becomes variable through an arc of 42°. From the extreme ends of the loading arm the coal is delivered either via a rotary spout placed in any direction into the ship's hold or where breakage is a consideration, the coal is deposited into the ship's hold through a Handcock anti-breaker.

The belts are 42-in. wide, troughed and driven at a speed of 350-ft. per minute, and each can deliver 500/600 tons of coal per hour.

Wherever it is necessary for the coal to turn a corner, a curved jigger is used. They are made quadrant shaped, working on a pivot actuated by an eccentric with a 3-in. throw chain-driven from the belt head drum. The incline of these jiggers is too flat to permit coal to slide down freely, but when oscillated they deliver it gently on to the belt below. These jiggers, as they are called, have proved wonderfully effective with all the 14 different classes of coal to be dealt with.

Fig. 23 shows the two loading berths, which are 450-ft. apart. The west loader is 800-ft. from the teeming point.

Each loading tower travels on two 4-wheeled bogies along 90-ft. of the arc of a track of about 100-ft. radius. Maximum height of delivery, 61-ft. above H.W.O.S.T.—outreach 55-ft. from the quay.

The jetty work carrying this appliance consists of two ferro-concrete main dolphins with connecting gangways back to the shore heavily braced to maintain a constant radius between the pivot point and circular track. The circular track on which the coaling tower travels required substantial foundations, and cylinders were used carried down about 90-ft. to a rock foundation. As first designed the tower, provided with two 4-wheeled bogies, travelled on a track provided with two 112 lb. flat-bottomed rails, 2-ft. 6-in. apart, with connecting steel sleepers—a 25-h.p. motor driving the wheels. In an exceptionally heavy gale one of the towers got out of control and, hitting the buffer stop, was so badly twisted that the lower part had to be rebuilt. To guard against a recurrence, a cast steel rack was fixed between the rails, strongly bolted down to the reinforced concrete beam spanning between the cylinders. A pinion on the tie-girder working over this rack is geared up to a brake drum, and the brake shoes are held off by an electric thruster brake when the tower is moving. When the electric current is shut off the brake holds the pinion so that it is impossible to travel the tower. Chains are also provided to further secure the structure each night when work is finished. These are also used when a gale is threatened.

Each tower has a 12-ton crane for the purpose of carrying an anti-breaker of the Handcock type, which is much used on the Tyne. The square tube is divided into compartments by a series of trays pivoted to two endless chains passing over sprocket wheels at the top and bottom. The trays travel down the tube with as much coal or coke as they can receive while passing the mouth of the shoot. Some are driven by a small motor, others work by gravity against a centrifugal brake which prevents them going too quickly. Their capacity is about equal to that of the conveyor. There are ten in use on River Tyne.

A larger coaling plant has been built by the Tyne Commission at Jarrow-on-Tyne, and opened for use in 1936. The illustration shown is an artist's impression of the finished work. It was made before the work was started, but it is sufficiently faithful a representation to use in a general description (Fig. 19).

Starting with a group of standage sidings connected to the colliery railways and to the London & North Eastern Railway, wagons gravitate down to the hopper house where the coal is discharged on to three conveyor belts. The empty wagons pass over the hoppers on to automatic electric lifts, and are raised to the level of the empty roads and then gravitate down to the level of the starting point. The three belts are taken up a fairly steep incline (about 18°) to pass over a public street and then down to the three loaders. At each change of direction in the belt line the coal is run down a curved jigger designed to reduce breakage as far as possible (see Fig. 9).

A public highway had to be crossed on account of the railway connection being on the opposite side to the river. A level-crossing was out of the question, and it was too costly to carry a multiple railway track over it. A conveyor belt is both light and easy to arrange for in the matter of approaches as it can climb quite a steep angle, compared with a railway gradient,

Fig. 21. Train of Boats

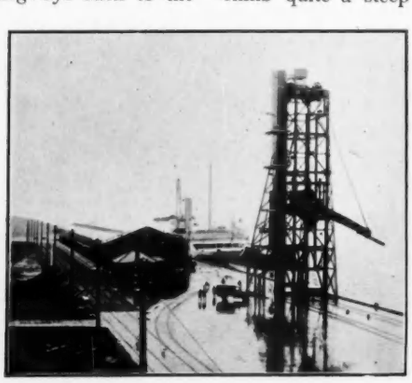


Fig. 22. Hoists

Fig. 23. Loading Berths

Methods of Coal Loading for Export Trade—continued

hence the adoption of this type instead of trying to take wagons of coal right up to the riverside.

The portion of the jetty carrying the movable towers was of reinforced concrete. The circular track is supported on a heavy R.C. beam, which rests on a series of solid square pillars built on groups of four R.C. piles. The pillar was first pre-cast as a square sleeve and then placed over the stripped tops of the piles and then filled up solid with concrete.

The ground at Jarrow was considered good enough for piles to be used. The back of this portion of the jetty was provided with raking piles to better withstand the pressure of vessels against the face.

The ferro-concrete work is heavily timber fendered. It has practically a 12-ft. wide timber jetty in front of it with double front piles—the single back one being fastened to the ferro-concrete pile work. This 3-pile fender structure is continuous all along the berth—when it leaves the ferro-concrete work it has a self-supporting jetty 24-ft. wide.

This shows the range of coal shipment. With anti-breaker in use delivery can be made to vessels from a height of 50-ft. above high water to 26-ft. below, measured from the underside of the anti-breaker, with a maximum outreach of 40-ft. from the face of the quay. Without the anti-breaker the height of delivery can be 65-ft. and the outreach 60-ft. The radial arm can travel over an arc of 27°, which gives a range up and down river of 45-ft. on each side of the central position at 60-ft. outreach.

The movable towers at this staith are driven by means of a pinion on the lower tie-girders which works in a cast steel rack. Superficially, it looks much the same as Howdon Staith, rack, pinion and gearings, but here the actual driving force is transmitted through the pinion to the fixed rack, which acts as a drive and as a brake, electric thruster brakes and solenoid brakes being used. Another point of difference between the Howdon and Jarrow plants is that in the former a break occurs in the transit of the coal along the loading belt in connection with the extension and retraction of the boom across the vessel causing a certain amount of breakage at this point. This has been eliminated at Jarrow by an improved method of telescoping the belt—shown in Fig. 17.

Fig. 18 shows a portion of the rack set in the concrete beam.

Adjoining properties are occupied by a paint manufacturer, and great care had to be taken to prevent the escape into the air of coal dust from the teeming operations in the hopper house and from the conveyor galleries. The anti-dust plant consists of three separate units with suction trunks around the teeming points to deal with the dust. Each unit has two sections of cotton bag filters of the enclosed suction type, each half being fitted with an exhaust fan. By stopping one fan, the other can reverse the air current through the bags and dislodge the dust which can also be dislodged by the hand-shaking gear provided. Six 10-h.p. motors are used for driving the exhausting fans. The dust is steamed as it falls from the hoppers below the filters, and is conveyed to the conveyor belts by a small scraper conveyor. Water sprays have also been installed at each teeming hopper. Although the material shipped varies from fine dust from the colliery company's dry-cleaning plants to large coal and coke, no complaint has been received so far from adjoining properties.

As will have been gathered from the above description, there are many methods of great diversity for shipping coal and coke. It is impossible to lay down hard and fast rules as to what should be provided, as regard must be paid in each case to local requirements and physical conditions.

Book Reviews

Puerto de Buenos Aires. Anteproyecto de ley para su organizacion, 1937: Biblioteca, "Liga Naval Argentina." Publicacion No. 1. Pp. 193, with two folder plans.

Feeling the necessity for letting the Argentine public understand the problems confronting the directorate of the National Mercantile Marine, the Argentine Naval League has issued this volume in order to give publicity to an advance project of statute law for the administration of the Port of Buenos Aires, as formulated by the Commission of Organisation of the Mercantile Marine—a body constituted by the executive concerned with national interests bound up in navigation in general.

This statement of the advance project is accompanied by an explanation of the reasons for its composition. It incorporates also the reports made by Mr. Kinart and Mr. Nijhoff, two engineers who, in 1906 and 1931, respectively, investigated the conditions in the port and district.

Within a short notice, it is impracticable to give consideration to the project in detail, containing as it does, a number of special features attributable to the local conditions and the national character of the port. In the preliminary review, however, of systems of administration in other countries, there is an error in stating that the Port of London is administered by the Thames Conservancy. That body, of course, went out of existence with the creation of the Port of London Authority in 1909. Nor is the number of members given correctly. In the case of Southampton, it is stated that the docks and basins are the responsibility of a "Company," without any reference to its railway associations, and that the piers (muelles) and the maintenance of the roadstead are in the hands of a "Commission," including representatives of the municipality, which is true in a sense, but rather inadequate as a description of the constitution and functions of the Southampton Harbour Board.

Zur Frage der Tragfähigkeit von Rammpfählen (on the Question of the Bearing Capacity of Driven Piles), by Dr. Ing. Wolfram Schenck. 64 pp.; 44 illustrations. Price (abroad) 3.60 Rm. Wilhelm Ernst & Sons, Berlin, 1939.

This booklet deals with a question which has been much discussed by engineers, viz.: the value of the point resistance as compared with skin friction in piles driven into alluvial material. About 1919, Mr. A. S. E. Ackermann made a number of experiments on small piles in remoulded London clay, and showed that the point resistance could be distinguished from the skin friction by forcing down with a rod an inverted pyramid shaped like a pile point and comparing its resistance with that of an ordinary full pile form. (See Trans. Society of Engineers, 1919-23). He found that the clay did not squeeze back into the open space behind the pyramid, but it is questionable whether the existence of this open space does not make the distribution of pressure rather different from that which exists round a solid pile.

Dr. Schenck has studied this problem in the light of the modern soil theories of Terzaghi, and shows that under load there must be a displacement of the pile point with respect to the surrounding soil, due to the difference in the vertical compression of the soil, and that of the pile itself. The latter compression is due partly to the point resistance and partly to the skin friction, and is particularly affected by the manner in which the latter is distributed over the length of the pile. He suggests that by the use of hollow steel piles, measuring rods and compressometers, it is possible to determine the compression at various places along the pile from the point to the surface, and, from a knowledge of the elasticity of the pile, hence to deduce the actual forces on the pile and their distribution.

The paper commences with a very clear analysis of the soil stresses on the Boussinesq principle, and the evaluation of the strains from Terzaghi's coefficients. After describing the manner in which piles are surrounded with a series of "bulbs" of equal stress (practically cylindrical or conical in form) he analyzes the soil strains and settlements due to the skin friction and those due to point resistance. Finally, he developes a series of "f" and "F^1" coefficients and their common ratio, according to the manner of distribution of the skin friction. From the suggested experiments, he believes these can be found, and will indicate the skin friction and point resistance separately, and also show the distribution of the former.

He claims that such experiments are necessary to solve the problem, which is not theoretically soluble, and urges the importance of practical investigation on the lines indicated.

The paper is quite valuable as a study of the pile-pressure problem, and his suggestions are certainly interesting and probably important. H.C.

New Sailing Ship for Research Work.

The R.R.S. "Research," built for the Admiralty, and to be launched on April 4th, will be the only vessel of its kind, and the results of its investigations will be placed at the disposal of all nationalities in the interests of safety at sea. She will supplant the American reseach ship, the "Carnegie," which was lost through fire off Samoa in 1929, and the Carnegie Institution of Washington, U.S.A., has co-operated with the Admiralty in designing the new vessel, which is built almost entirely of wood and bronze, so that she shall be, as far as possible, non-magnetic.

Every detail of the ship's equipment and fittings has been studied with a view to eliminating iron and steel, in order to ensure the successful operation of the delicate instruments which the ship will carry so that exact records of compass variations may be made.

The programme of the work to be undertaken includes, besides research on the earth's magnetism at sea, investigation of atmospheric electricity, meteorological observations, including upper air observations by means of pilot balloons, deep-sea soundings, and possibly marine biology.

The first cruise will be to the Indian Ocean, where data on magnetic variation are most needed.

German Waterways and Harbours

Retrospect for the Year 1938

THE following review of the progress made during the year 1938 on German inland waterways and canals and at German ports has been furnished by the State Ministry of Communications. It is a translation of the German text in an abridged form.

The State Waterways Administration in 1938

The constructional activities of the State Waterways Administration in 1938 comprised the further improvement of the German rivers and their tributary and connecting canals so as to compact them into one efficient network of waterways. Works were also carried out for the improvement of seaports and sea routes, and for the protection of coasts and islands. Finally, the existing extensive system of waterways were maintained in capacity, and the large plant for the operation and maintenance thereof was kept in condition.

The most notable events of the year 1938 were the putting into commission of the Mittel-land Canal up to the Elbe and the conclusion of the accelerated execution of the Rhine-Main-Danube connection. The inclusion of Austria and the Sudeten areas brought extensive reaches of German rivers, especially the Danube, but also the Elbe and the Oder, into the care of the State.

In spite of a perceptible lack of workmen and engineers and the scarcity of certain structural materials, definite efficiency and advances can be reported in all departments of the S.W.A. The following details can be reported on the work on the various river and coast areas in 1938.

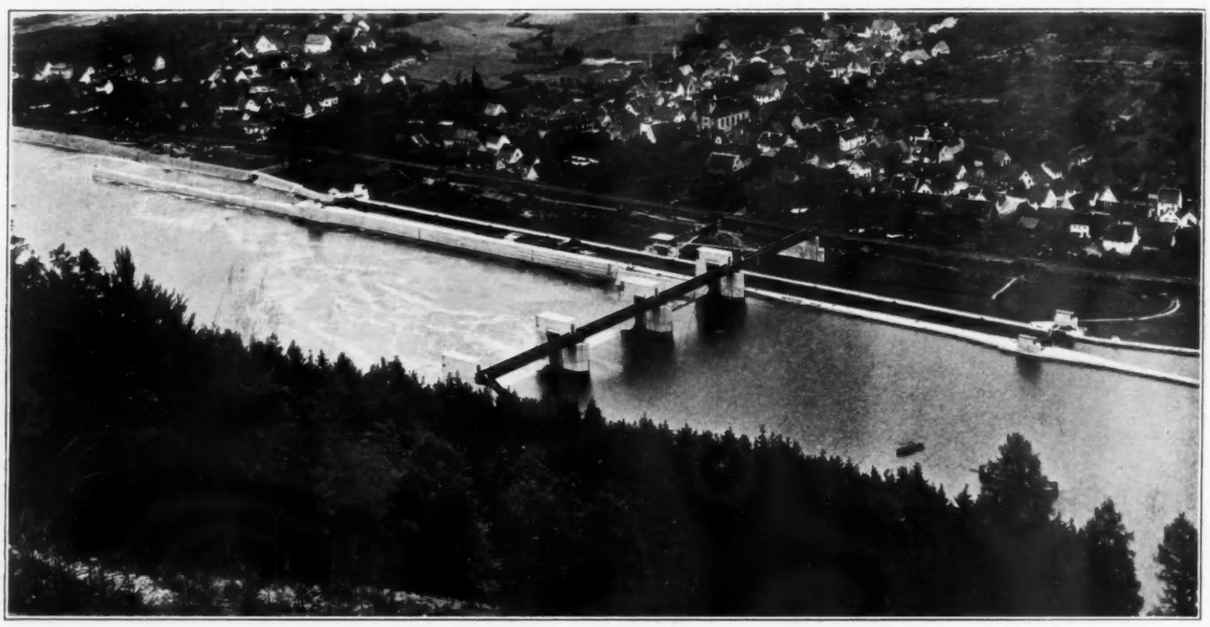
1.—Rhine-Main-Danube Region

The regulation works in the upper Rhine, between Basle and Strassburg/Kehl approached completion. The traffic on the Rhine to Basle has continuously increased and amounted, in 1937, to some two-thirds of the traffic of the whole three million tons in Basle Harbour.

According to the law of 11th May, 1938, concerning the Rhine-Main and Danube connection, and the improvement of the Danube, it was laid down that the Rhine-Main-Danube Waterway should be ready by 1945. In order to realise this rapid execution, the greatest efforts must be made. The continued lack of working power rendered the advance of this project still more difficult. In 1939, the work must be carried out on a larger scale, on the Main as well as in the canal reach between Bamberg and Kelheim.

After the reunion with Austria, it was necessary to make immediate preparations for the inclusion of the improvement and maintenance of the omitted parts of the Danube in the latter years of the programme. The Danube will be brought to the highest capacity by a mean-water regulation throughout the whole Austrian reaches, and where necessary also by a low-water regulation. For this purpose, it is necessary to improve the reaches dangerous for navigation at and below the so-called "Greiner Struden," by damming up. The construction of the ponded reach Ybbs-Persenbeug, which, in addition to the navigational lay-out, includes a power plant with an output of more than 800 million Kilowatt hours, was begun in the middle of 1938.

The works on the Neckar, between Heilbronn and Stuttgart, which serve both for navigation and water-power, were carried a stage further. It is the intention to extend a deep ship channel to the newly-constructed port at Stuttgart in 1945.



Weir and Locks on the Main near Faulbach

The projects for the improvement of the Upper Danube from Ulm downwards have been so far successful that apparently early in 1939 the construction of several ponded reaches for power production can be reckoned on. The requirements for electric energy from water-power have so much increased, especially in Southern Germany, that endeavours must be made to develop water-power to a greater extent than at present.

2.—West German Canals

The works on the Southern stretch of the Dortmund-Ems Canal (south of Bergeshövede) made satisfactory advances in 1938. It can be said that about half the whole length (round 115 kilometres) is almost finished. Work is also in progress on practically all the other reaches.

On the northern reach of the canal, between Bergeshövede and Papenburg, the works commenced in 1937 in the Hessel-Papenburg parallel canal at Ems were extended. 55 kilometres of this 80 kilometre long parallel canal are under construction. In some parts of small extent the earthworks are almost complete. It appears probable that the works on the southern reach will be so far advanced by 1940 that vessels of tonnage specified for the Mittel-land Canal can be admitted. In the northern reach the work will be prolonged until 1944.

The canal traffic, which has noticeably increased in 1938, must not be disturbed by the widening operations. Nevertheless, no important restrictions on the canal works have occurred. It is anticipated that none such will occur in the future as, from 1st January, 1939, the towage service, and with it the traffic upon the most heavily used southern reach, will be exclusively controlled by the State Towing offices.

3.—Weser Region

Among the constructional projects in this region must be mentioned in the first place the canalisation of the Middle Weser from Minden to Bremen for 1,000-ton vessels. In addition to the two existing lock stages, five new ones are to be provided. The past year saw the further execution of the extended lock canals, especially the initiation of several large structures, and also the retaining weirs and navigation locks at Petershagen and

German Waterways and Harbours—continued

Drakenburg. The weir and lock at the Langwedel lock stage are practically completed. In spite of the hindrances due to perceptible lack of workmen and engineers, the progress in 1938 was considerable. As the provision of the water requirements of the Mittel-land Canal and the " Hermann Goering " State scheme at Salzgitter is dependent on the correctly timed completion of the canalisation of the Middle Weser, every effort must be made to complete the canalisation works, as planned, in 1942.

Coast Protection—West side of Borkum

The low-water regulation of the Weser from the mouth to Bremen was regularly continued by the construction of a series of wider sectional reaches.

The canalisation of the Werra, which is of special importance for the Hessian and Thuringian alkali area, requires to be of service to 1,000-ton vessels. The parallel canals and the locks are, however, of such dimensions as will serve for 1,200-ton vessels, so that ultimate admission of these vessels will only require the deepening of the river stretches. The preparations for the reach from the mouth to Wartha have progressed so far that next year the actual construction can be commenced. The plans for the canalisation of the 50-kilometre stretch from Martha to Merkers, the centre point of the alkali area, are almost complete.

The decision, made on the 1st November, also to commence the plans for the 135-kilometre Werra-Main Canal from Merkers to the Rhine-Main-Danube Waterway at Bamberg, has been received in interested industrial circles with great satisfaction, since thereby a further stride is taken in the realisation of the great task of the Weser-Werra-Main-Danube interconnection.

The works for the raising of the water-level in the Ems-Weser Canal, for the reception of 1,000-ton vessels, has made good progress. The projected work will probably be ready by the 31st March, 1940.

Finally must be mentioned the revived project for the Hansa Canal, which, from Bramsche on the Ems-Weser Canal through Achim near Bremen, would lead to Hamburg and Lübeck. In May of this year the preparatory division arranged in Hamburg has been commissioned to re-shape the present canal design for 1,500-ton vessels, and also to design the widening of the Ems-Weser Canal in the reach Bevergern-Bramsche, and also the widening of the canal to Lübeck.

4.—Elbe Region

Low-water regulation of the Elbe.—The works on the change of the river bed with the object of equalising and increasing the navigable depth were continued throughout the whole extent of the German Elbe; on account of the lack of labour force, the progress was, however, less than in the previous year.

At the Magdeburg lock stage, the lock works were greatly advanced at the beginning of the year, but later the lack of workers, and to some extent the lack of materials, caused considerable delay.

Mittel-land Canal—Principal Canal. On the 30th October, the Rothensee Canal-lift and the Brunswick-Elbe section of the Mittel-land Canal were put into service, and this was also the occasion of the formal opening of the Mittel-land Canal by the Fuhrer's representative, State Minister Rudolf Hess. Hereby there is practically achieved an inland water connection right across Germany from the Rhine to the Elbe, Havel, Spree and Oder, and further to the waterways of East Prussia. The ultimate navigable route towards the East will not go by the Rothensee Canal-lift, but will cross the Elbe by a large bridge and will reach the Elbe-Havel Canal (Ihle and Plauer Canal) by the double canal-lift at Hohenwarthe. These two large structures will be ready in 1942.

Improvement of the Saale.—The new lock at Bernburg was put into service. The opening of the Rothenburg lock, which is ready, is postponed until the removal of a large rock-fall in Oberhafen. The locks at Calbe, Alsleben and Merseburg are structurally complete; constructional operations have begun at the Wettin lock stage.

Elster Saale Canal.—The canal reach is far advanced: at the Wüsteneutzch lock-flight the structures must soon be put in.

Hohenwarthe Groynes.—In spite of the lack of workmen and cement, a further 160,000 cubic metres of spur walling were carried out.

Feeder Canal Bleckenstedt-Hallendorf.—The works for the execution of the feeder canal to the Hermann Goering works are in full swing. At the harbour basin, with which the canal ends, at the furnace-area, the earthworks have been started. In the construction of this canal alone 3,000 workmen are occupied.

5.—Waterways of the Mark (Brandenburg) to Mecklenburg

In the region of the Mark and Mecklenburg waterways there stand in the foreground the works for the re-shaping of the Berlin waterways, which are conditioned partly by the City Reconstruction Scheme for Berlin of General-Construction-Inspector Professor Speer and partly by the inclusion of the Berlin waterways in the West German waterway net following the completion of the Mittel-land Canal. In the scheme of the General-Construction-Inspector were the works for the displacement of the Spree at the Königsplatz, which, together with the general commencement of the reconstruction of Berlin, were inaugurated ceremonially on 14th June, 1938, by the State Minister of Communications Dr. Dorpmüller.

The works for the improvement of the Berlin waterways for the increased traffic with West Germany cover the Spree, the Landwehr Canal and the Teltow Canal.

In the Spree itself the entrance reach is to be improved. It will also receive a new connection to the Western harbour. The works, which have been for some years in progress for the reconstruction of the Mühlendamm, will be regularly extended in close connection with the work of the City of Berlin for the re-shaping of the Inner City.

The Landwehr Canal is to be provided with new and enlarged locks, in order that the discharge from the Spree may be more effectively removed.

The Teltow Canal, which in the future will serve 1,000-ton vessels in the traffic between the Mittel-land Canal and the East harbour in Berlin, will be reconstructed for this purpose.

The works for a new lock at Klein-Machnow have been begun.

Among the remaining steps which have been taken in the Kurmark and in Mecklenburg, the following call for special notice:—

Construction of a capacious flood basin at the mouth of the Havel, which will protect the lands from exceptional high waters.

Improvement of the Havel between Brandenburg and Paretz for the transmission of traffic from the Mittel-land Canal to Berlin.

Measures for the amelioration of the navigation and flood conditions on the upper Havel Waterway.

New construction of a second lock at Lehnitz for the raising of the capacity of the Hohenzollern Canal at its take-off from the Havel.

Bank Protection on the Oder

Construction of a new lock with spillway in the Friedrich-Franz Canal in relation to the improvement of the Elbe Waterway in Mecklenburg for 400-ton vessels. By reason of the new lock stage, two old stages became superfluous.

In addition, the arrangement of the high-water discharge renders possible the lowering of the Lewitz.

The growing demands on the water storage of the Havel and Spree by industry and traffic render necessary, especially in view of the modernisation of the State capital, measures for the systematic control of the water economy. The State Waterways Administration, in conjunction with other parties, is making the necessary preparations now.

German Waterways and Harbours—continued

6.—Oder Region

The improvement of the Oder Waterway below Breslau to Lebus was carried out by means of levelling, dams, aprons, etc. In especial the works at the sharp turn at Laeskau were completed.

The Turawa retention basin on the Malapane River, which was essentially ready in the previous year, was able to be filled for the first time (firstly to half height). In the upper part of the retention basin the supplementary work (placing of a spur-groyne, dykeworks, etc.) was advanced.

Harbour of Harburg—Wilhelmsburg

On the Klodnitz at Stauwerder the first of the three intended retention basins with a pondage of about 10 million cubic metres was filled for the first time.

The structures connected with the planned retention reservoir in Weistritztal at Berghof were carried on. In especial the earthworks for the shifting of the railway between Metkau and Ingransdorf were begun.

The works on the Adolf-Hitler Canal, which connects Gleiwitz with Cosel, were systematically extended. Of the six locking stages four are ready. The foundation structures for the other two are almost completed. The last parts of the earthworks for the canal bed were disposed of.

The works in Gleiwitz Harbour were also regularly carried on. The slipways are for the most part ready. In the coming year the equipment of the harbour with cranes, etc., will be done. The opening of the canal and harbour will probably follow in 1940.

The works for the shifting of the Oder at Ratebor for the protection against high spate flooding was carried on. After making ready the Markdorfer Street Bridge, the works for the Stadtwald Bridge were taken in hand. The superstructure for the new railway bridge over the new course of the Oder is partly completed, the piers of this bridge having been erected in 1936.

The preparatory and design work for the construction of the Oder-Danube Canal will probably be taken up at an early date.

7.—East Prussia

The building of the Masurian Canal is proceeding regularly. Apart from small residual works, there are still three locks to be got ready, of which the two largest at Furstenau have a fall of 17.5 metres each. The canal will probably be put into use in 1940.

In connection with the large improvement works in the region of the Inster, one of the two sources of the Pregel, there will be commenced, in 1939, operations for the improvement of the canalised Pregel from Insterberg to Wehlau for the discharge of the raised summer high water.

Ocean Harbours

The improvement of the public harbours in Emden, Wesermuende, Cuxhaven and Büsum was carried on in accordance with the projected plans in a satisfactory manner, in spite of the difficult conditions in the structural industries.

In Emden harbour, contrary to the traffic increases of the year, there occurred a certain quiescence which was essentially referable to the scarcity of goods traffic on sea and rail which occurred, specially in the latter months of 1938.

On the other hand, in the fishing harbours of Wesermuende and Cuxhaven there was again an increase of about 10% in the fish loadings.

Ocean Routes, Island and Coast Protection

Kaiser-Wilhelm Canal.—The works for the restoration of lost section were carried on regularly.

Among the more important constructional operations there should be mentioned the widening of the Swinging road bridge at Rendsburg by the conversion of the present footways to cycle tracks and arrangement of new footways of 1.5 metres breadth on both sides, and the reconstruction of the truck mechanism in the lock tower at Brunsbüttelkoog. The latter followed the example of Bremerhaven, substituting gearing operated from the land for the present mechanism carried on the tower.

The increase in the traffic with large ships has necessitated the enlargement of a small passing space into a large one.

Ems Area below Papenberg

Structural works on the banks of the Leda must be designed with regard to the position of the dyke-works with which they are technically connected; they will, if possible, be renewed in the winter 1938/39. The preparations for locking off the Leda are almost ready.

For the removal of the causes of river deterioration in the region of the lower Ems at the Knock in earlier years a training wall and spur dam were installed. A section of this training wall, which no longer conformed to the intended height of 3.0 metres above mean spring low water, has now been raised, in order to discourage further deposition of sand from the channel water behind the works.

Borkum Island

Since observations of the effect of the previous protection work (submarine groynes) have shown the basic correctness of the system, this construction has been carried on.

German Waterways and Harbours—continued

Ostsee Province, Pomerania

The groups of groynes undertaken in past years at Neuendorf-on-Hiddensee for the protection of the crumbling shore have been systematically prepared. Similarly, the protective works on the collapsing steep shore on the north part of Hiddensee Island have been carried out: they consist of the erection of a stone wall and some stone groynes. They serve to protect the island, and especially the Dornbusch light tower with its fog and storm signals.

The dredging works for the betterment of the western approach to Stralsund were regularly carried on, the soil being pumped ashore for reclamation purposes at Bock.

Between Dievenow and Walddievenow protective works were undertaken for the strengthening of the dunes and the security of the shore. The navigable channel of the Stettiner Haff at Peene was improved by levelling of the Karniner Passage.

The widening of the shipyard basin in Swinemuende was begun.

Navigation Marks

In the region of marine signals a series of operations was carried out in 1938, which had principally the purpose of increasing the luminosity of lights, the enlargement in sound strength of wind and fog signals, and a perfecting of the senders from radio signal stations. Next were the arranging of new plants and the improvements required to existing plants, in order to cope with the calculated requirements of the expanding traffic.

Strengthening of Groyne on West Shore of Borkum by double sheet piling in steel

Thus numerous lights on the German East Sea (Baltic) and North Sea coasts during past years have been equipped with electric installations and by the introduction of modern high capacity lamps have been essentially strengthened.

New installations appeared on the coasts of East Prussia by the lighting of the harbours of the Haff, on the Pomeranian coast, by the lighting of the waters of western Stralsund, on the coast of Schleswig-Holstein by the combination of adjacent lights as the result of the design of a unitary river maintenance lay-out, consisting of a Diesel electric duplicate plant with automatic switch gear—whereby, in addition to increased light intensity, greater reliability and economy was sought—and finally, in the Elbe area by the construction of a new directional light to meet the growing demands of shipping on the Elbe.

In regard to fog signals, mention should be made of the replacement of the antiquated "Sassnitz" pneumatic fog signal plant by a modern electrically-driven diaphragm-transmitter plant. There was also a series of other details, such as the construction of a radio signal station at Brüsterort, and the establishment of fog signals at Stilo, Stubbenkammer, Griefswalder Oie, Friederichsort, Neukuhren and Aussenrandzel, and the renewal of the hydrophone senders at Stubbenkammer.

Vessels and Equipment

In the construction of vessels for the S.W.A. special stress was laid upon the use of domestic fuels for operation. Many new tow-boats in the State Tug services were supplied with suction gas engines, which were operated in conjunction with producers by anthracite or brown coal coke. Experience has shown that for inland vessels this new method of operation is useful and capable of development. Trials with high-pressure steam plants have also proved successful on inland vessels. As to ocean ships, there is specially noteworthy the construction of four new passenger vessels for the East Prussian Sea Service, which are still building. Here again, to save foreign exchange, oil-firing has been avoided, and a new method of coal-firing has been adopted. Two ice-breakers have been made ready for the Kaiser-Wilhelm Canal and the Kurische Haff, respectively. The Hamburg Shipbuilding Research Institute received various orders for investigations as to stability and rolling, and undertook numerous model experiments for the testing of the navigational characteristics of newly-built ships.

Inland Traffic Development

The traffic of the German inland harbours rose in the interval, January to October, by about 6%, as compared with the previous year. In the whole year the quantity of the total goods moving, which in 1937 amounted to about 133 million tons, was at least 139 million tons, i.e., an increase of some 4½%.

The Rhine traffic rose by 4%, the transit through Emmerich by 5%, but the traffic at Duisburg-Ruhrort, on the other hand, sank by 11%. The traffic of the Neckar and the Danube rose considerably—about 15%. The traffic at Hamburg and Berlin rose only about 4%. The traffic with East Prussia through the Polish Corridor up to the end of October exceeded that of the previous year by 86,000 tons, about 21%. The traffic on the canals shows, with the exception of the Rhine-Herne Canal, marked rises. On the Mittel-Land Canal it amounted to 34% (Anderten lock), on the Coast Canal 97%, the Dortmund-Ems Canal at Muenster Lock 22%, the Lippe Canal 60%.

The previous data are only valid for the period January to October. For the remaining months of the year, on account of the effect of the transport position, an essentially different state of things occurred.

The total traffic in the Kaiser-Wilhelm Canal in the same period, as compared with the high values reached in the previous year, was slightly down.

German Ocean Navigation in 1938

1. Increase of Ocean Traffic

Although world trade definitely receded in the first ten months of 1938, the ocean traffic in German harbours, apart from some fluctuations, maintained, or even exceeded, the previous levels. The continued demands of German National Industry for raw materials and other overseas goods had a stronger influence on the volume of imports than that of the world industrial disturbances on the volume of exports. Compared with the same interval in the previous year, the ocean traffic in German marine harbours rose by 7%, the goods traffic by 6%, and the coastal traffic by 11%. The ocean traffic in the Rhine harbours remained within the limits of the previous year. Among the large ocean harbours the Bremen group shows the greatest increase of traffic with 12%; Hamburg and Stettin had an addition of 3%, while the harbour of Emden showed a small set-back of about 2%.

2. Share of the German Flag in Ocean Traffic

In the stated interval the share of the German flag in the transport of goods to and from Germany also rose. In Bremen the increase was over 12%, attaining some 76% of the ocean traffic there. In all other important German ocean harbours, increases to the German flag occurred, even if but small.

The strong rise in freights in 1937 was followed in 1938 by a fall. According to the index (1913=100) the ocean freights in 1937 and 1938 sank to 86.5% and 76.6% respectively. The fall in rates affected tramp shipping more than the regular lines, which were secured by long-standing agreements and conference contracts against a rapid decline of rates, but for the same reason they were only to a moderate extent benefited by the freight rises of 1937.

The military developments in the Far East caused disturbances in the German ocean lines in that traffic area during 1938. The continuation of the Spanish Civil War had the result that German sea trade with the Government area remained very low.

3. New Construction and Earning Power of the German Fleet

For the first time since 1932 the German commercial fleet tonnage passed the four million mark: it had on the 1st July, 1938, some 8% greater gross capacity than on the same day in the previous year. This addition is the largest which the German commercial fleet has shown since the transition of power in 1933.

In spite of the strong demand on the German shipyards by foreign orders, in 1938 up to about 215,000 gross register tons of new shipping capacity was incorporated into German shipping. The orders in hand for German account at the German shipyards amounted, on 1st October, 1938, as in the previous year, to about half a million gross tons. On account of the reduction of costs abroad and the consequent competitive advantages of foreign flags, the German yards were again secured in 1938 against additions to the building costs, out of national funds. Even so, the State assistance was accompanied by certain variations, which produced only a partial compensation for the differences of cost to the German yards as against those of yards in lands with a depreciated exchange.

Proposal to Enlarge Lyttelton Harbour.

A proposal for enlarging Lyttelton Harbour is under consideration by the Harbour Board. Under the scheme, the area of the harbour will be increased from about 105 acres to 310 acres, and the work will involve the dredging of a new channel and turning basin at an estimated cost of £167,000, and the construction of new breakwaters at a further cost of £630,000.

Karachi Port Trust

Excerpts from the Administration Report for the Year ending 31st March, 1938

Finance

In round figures the ordinary Revenue Receipts for the year were Rs. 82,98,000, as against Rs. 74,15,000 in the previous year, an increase of 12%.

The Revenue Account expenditure on ordinary items was Rs. 73,77,000, as against Rs. 71,05,000 in the previous year, an increase of 4%.

The financial result was a surplus of Rs. 9,20,900 on the year's working.

A sum of Rs. 73,500 was withdrawn from the Reserve Fund during the year, for Capital works, and a sum of Rs. 1,812 was credited to it on account of profit on interfund transfer of scrip. At the end of the year, the Reserve Fund stood at Rs. 51,57,325.

Cargo

The total volume of imports and exports was 2,405,000 tons, or an increase of 15.3% over the previous year's figure of 2,086,000 tons.

Imports were 929,000 tons, or an increase of 14% over the previous year's figure of 815,000 tons; exports were 1,476,000 tons, or an increase of 16.1% over the previous year's figure of 1,272,000 tons.

The year under review constituted yet another record, both as regards exports and the total volume of trade, exceeding the previous records of the years 1936-37 and 1928-29, respectively.

Shipping

The figures indicate that foreign-going vessels entering the port and using the ship wharves were more than those of the previous year by 63 in number, or 9.8% and by 212,948 register tons, or 10.6%.

Coasting vessels entering the port, whose cargo is mainly handled by lighters over the Native Jetty, were less by 28 in number, or 9.3% and by 26,263 net register tons, or 5.7%.

The number of country craft using the Napier Mole Boat Wharf showed an increase over the previous year of 3.7%.

General

An additional passenger pier was constructed at Manora at a cost of Rs. 12,366, for the convenience of the public visiting Manora, the old passenger pier being at too low a level for use during the monsoon.

The Seaplane Port Station and the approach road mentioned in the last year's Report were completed during the year.

A landing jetty and slipway were also constructed by the Port Trust on behalf of the Central Public Works Department. The slipway, which is of reinforced concrete, extends down to 8-ft. below low water, and thus enables the flying boats to be hauled up out of the water at any state of the tide.

The Empire Airmail Scheme was inaugurated at the end of February, 1938.

The report is signed by Col. D. S. Johnston, the Chairman.

Port of Hobart, Tasmania

Excerpts from the Annual Report of the Marine Board for Year ended 31st October, 1938

Improvements

General.—Suggestions have been placed before the Board by parties interested for improving the wharf accommodation, some of which if carried out would entail an expenditure of approximately £500,000. The suggestions include the scrapping of Queen's and King's Piers, Constitution and Victoria Docks, and the erection in their stead of one large pier, running back to Davey Street; also the shortening of Ocean Pier and excavation at the inner end right back to Davey Street. The suggestions are under consideration of the Board.

The Board has decided so far to make immediate preparation for the completion of the reconstruction of Prince's Wharf, in accordance with recommendations of the Engineer and Harbourmaster, so that the work may be proceeded with between the next two overseas fruit shipping seasons, and to take into consideration the question of widening Ocean Pier after the conclusion of the 1939 overseas fruit shipping season, and before the commencement of the 1940 season. The estimated cost of reconstructing the balance of Prince's Wharf is £38,000, and of widening Ocean Pier £80,000.

Ocean Pier.—The piles in this pier were inspected by the diver, and the Engineer recommended that reinforced concrete sleeves be placed round 116 of them as soon as possible, and the balance of the damaged piles (220) be attended to during the next five years. Estimated cost of the whole of the work £10,000. The pile spacing in this pier is 12-ft. by 10-ft. The work will be put in hand shortly.

Queen's Pier.—In this pier there are 110 piles eaten through, or nearly so, by limnoriæ, and 87 of 9-in. and less diameter, the balance being of 10-in. and over. The pile centres in this pier are 6-ft. 8-in. by 10-ft. This pier is about 37 years old, and so far only a few piles at the shore end have been renewed. It is considered that by renewing about 200 piles with some minor repairs, another 10 to 15 years' service may be expected. The cost is estimated at £5,000, and the work will be put in hand as opportunity offers.

King's Pier.—The pile spacing in this pier is 10-ft. by 10-ft., and about 150 piles require renewing, at an estimated cost of £4,000. With this carried out, the life of the pier will be about 15 years.

Trade of the Port

The volume of cargo passing over the Board's wharves shows a small decrease, compared with last year, as under:—Cargo inward, 1936-37—247,645 tons; 1937-38—245,067 tons. Outward, 1936-37—280,360 tons; 1937-38—278,227 tons.

Financial

A further reduction in wharfage rates of 10 per cent. came into force on the 1st July, 1937, and its effect has been a reduction of about £2,000 in the rates collected. To make a comparison on the same scale of importations as the previous year, the reduction should have been about £3,000, so that while the revenue has been less, the trade of the port has increased.

The principal sources of revenue during the last three years were:—

	1935-36.	1936-37.	1937-38.
	£	£	£
Wharfage Rates	33,046	33,421	31,133
Tonnage Rates	6,477	6,798	6,608
Pilotage	2,600	2,559	2,401
Rents	2,671	2,502	2,283

Total ordinary receipts were £46,348, as compared with £49,320 for 1936-37, and £48,244 for 1935-36.

Shipping

A falling-off in the number of vessels visiting the port and in the tonnage is recorded when compared with the record of 1936-37. The crews of the vessels arriving during the year numbered 27,410.

	No. of Arrivals.	Net Tonnage.	Gross Tonnage.
1935-36	631	1,030,479	1,737,984
1936-37	630	1,094,240	1,849,007
1937-38	593	1,066,820	1,813,794

Publications Received

A copy of the Dieppe Harbour and Airport Annual for the year 1939, published under the direction of the Dieppe Chamber of Commerce, has been received. The present edition, which contains a plan of the port and its environs, and a number of illustrations, is produced on the same lines as last year, and gives full details of charges for pilotage, towage, the use of cranes and warehouse accommodation and other information connected with the general working of the port. A list of the names and addresses of Officials in charge of the Consulates is also included, as well as tables showing the times and heights of high tides.

We have also received from Messrs. Redpath, Brown & Co., Ltd., a copy of the pocket edition of their handbook "Structural Steelwork—1938." It has been specially compiled for use outside the office, and the tables have been selected to combine the maximum of utility with a size convenient for the pocket. Properties and safe loads are given for joists and joist compounds as beams and as stanchions, filler joist floors, solid round columns, slab bases and grillages. Other tables relate to rivets and bolts, weights of sections and materials, mathematical tables and conversion equivalents. The calculations are in accordance with the requirements of the latest British Standard Specifications. It is a very handy and compact production.

National Savings Holiday Schemes

Wide attention has lately been drawn to the schemes put forward by the National Savings Committee for the encouragement of saving for holiday purposes. The schemes have been adopted by a large number of firms in many trades. One of the main reasons for the success of the schemes is the fact that they have been given commendation by many important Trade Federations. The following are amongst the organisations which have supported the schemes in this way: Coal Mining and Mining Association; Engineering and Allied Employers' National Federation; Glass Manufacturers' Federation; Surgical Instrument Manufacturers' Federation; Dock and Harbour Authorities; National Federation of Vehicle Trades; Iron and Steel Trades Employers' Association. Similar action has been taken by certain leading Trades Unions.